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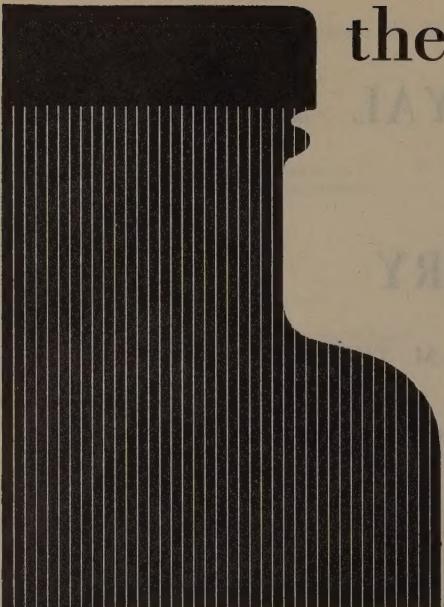
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# OUR NEW PRESIDENT

## Sir William Slater, K.B.E., F.R.S.

WILLIAM KERSHAW SLATER is a product of Oldham Hulme Grammar School and the University of Manchester, where he graduated in 1914 with first-class Honours in Chemistry and was awarded a Graduate Scholarship and the Leblanc Medal for the chemistry of dyestuffs. Having been rejected for military service he joined the staff of the deputy inspector of high explosives under Professor H. B. Dixon, where he was engaged in the sampling and analysis of explosives, coupling this work from 1916 with a demonstratorship in chemistry.

He continued at the University until 1920, when he took a post with a cotton combine as chemist. They thought they ought to have a chemist but had no idea what he should do, so he began with the Lancashire boilers—with considerable success. He undertook a variety of jobs and dealt with complaints. However, in 1922, deciding that the cotton trade was about to be anything but flourishing, he joined Professor A. V. Hill, then at Manchester, and, with a grant from the Medical Research Council, began work on the biochemistry of muscle. In 1923 he was awarded a Beit Memorial Medical Research Fellowship, and in the following year he followed Professor Hill to University College, London, and, with further Beit Fellowships, worked for four years in connection with anaerobiosis in insects, during which he was awarded the D.Sc. degree (1926).

In 1928 he was invited to take charge of the scientific work arising from the experiment in rural reconstruction at Dartington Hall in Devonshire, quickly becoming involved in the administration of the farming and other rural industries and establishing a general-purposes laboratory for all aspects of agricultural chemistry.

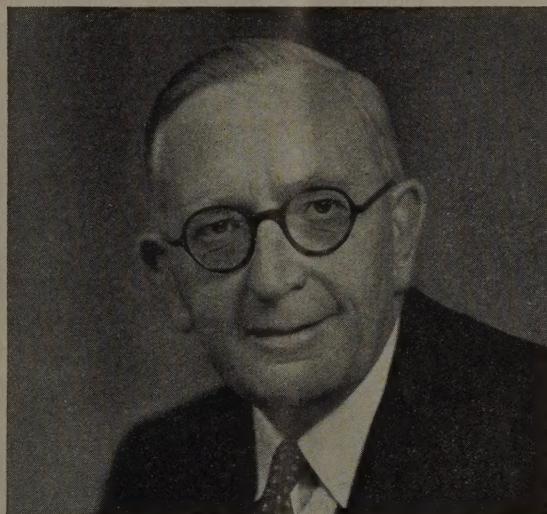
In 1943 he was loaned to the Ministry of Agriculture to help with the drive for increased food production. A year later he joined the staff of the Ministry and, when the new Advisory Service was set up, became one of the senior advisory officers responsible for the specialist officers—chemists, entomologists, plant pathologists and bacteriologists. He remained in that post until 1949,

being Secretary of the Agricultural Improvement Council during the same period. Then followed his most important and exacting task as Secretary to the Agricultural Research Council, from which he retired last year. During that period the annual sum spent on research rose from around £1m. to some £5·5m.; new institutes were established and the old ones greatly expanded. At the same time not only was the standard of the work maintained but the general status of agricultural research was considerably enhanced. In 1951 he was created K.B.E., in 1952 received the honorary degree of Doctor of Science, Queen's University, Belfast, and in 1957 was elected to Fellowship of the Royal Society.

Like so many active men, Sir William has recreations only when he has time. One of the results of this is the never-ending demand for his unskilled labour—as he calls it—in the garden, though he does find time for occasional painting in oils. With so many calls on his time, the Institute was fortunate in securing his services on the Council in 1953–56, though it has long been

realized that he has had a permanent and keen interest in chemistry as a profession quite apart from his great interest in chemistry as a science. Both, as he rightly points out, are equally important, but Sir William has stood out since the last war against the tendency to emphasize the science at the expense of the profession. A relatively small proportion of chemists ever undertake fundamental research; the rest will serve the community in a wide variety of professional capacities. It is important that the status of all these chemists should be preserved. This attitude has guided his activities over the years. He has taken a personal interest in those fortunate to serve under him and usually succeeded in learning a considerable amount about them.

Lady Slater is also an Honours Chemistry graduate of Manchester. We are glad to hear that she proposes to enter fully into the round of duties undertaken by the President in these days, and to join him on his various journeys in and out of London.



# CHEMISTRY AT THE SCIENCE MUSEUM

By FRANK GREENAWAY, M.A., M.Sc., F.R.I.C.

*Deputy Keeper, Department of Chemistry*

For more than a hundred years the Science Museum has played a unique part in the scientific and educational life of this country. More people visit it (well over a million a year) than any museum in Europe except the Louvre. Many thousands attend special lectures: parties of children; teachers in training; university and technical college students; industrial trainees; art students studying industrial design; students of economics studying the basis of commerce and industry. The handbooks of the collections are used all over the world. As a centre of information on all branches of the physical sciences and their industrial applications its senior staff are consulted by the press, radio and television, educational, industrial, advertising and commercial concerns of all kinds. This high status has been attained only after a long period of development.

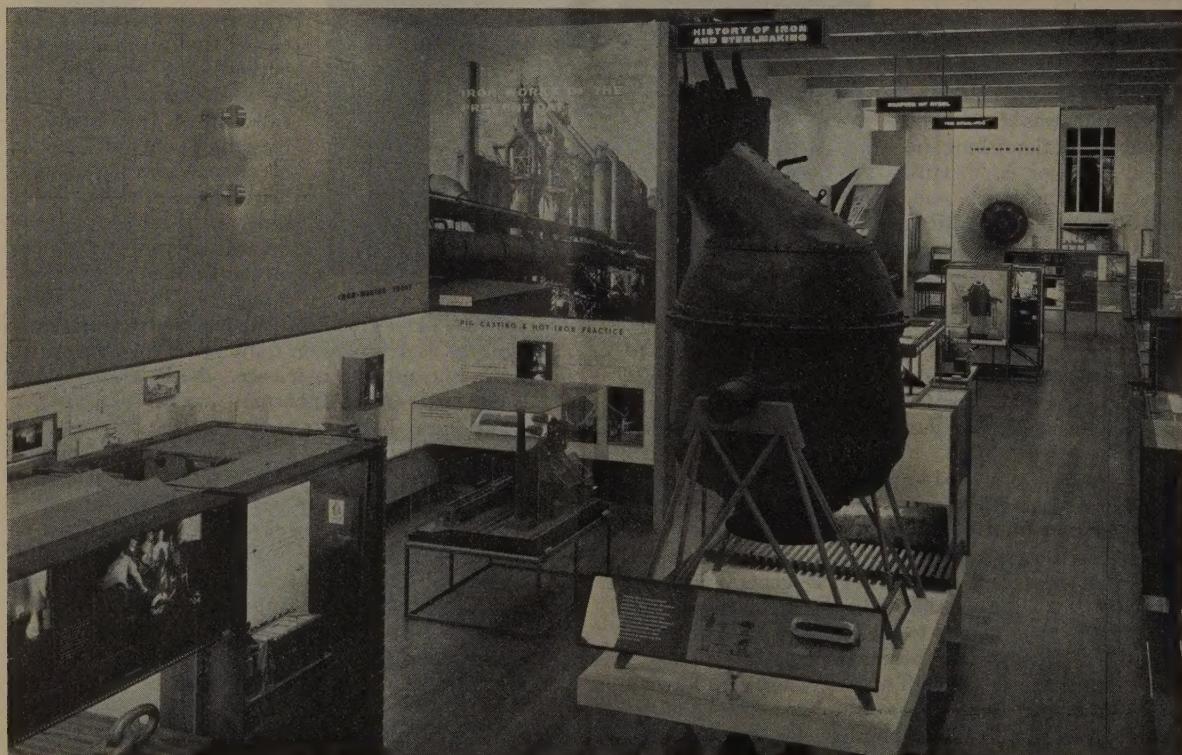
In 1857 the South Kensington Museum was established by the British Government as a place where 'the works of excellence of all ages' might be brought together for the instruction and inspiration of all. At

the beginning of this century the art and science sides were separated administratively, the art side being thereafter known as the Victoria and Albert Museum, the science side as the Science Museum, a name which conceals to some extent its intimate association with industry, technology and public services.

In 1912 a policy of development and expansion, which has been severely delayed by two wars, was agreed upon by the Government of the day. It has recently become possible to take a new step forward, and H.M. Government has been able to agree to the erection of a Centre Block, which will increase the available exhibition space by some 60 per cent.

Work on this extension is now far advanced and it is expected that it will be handed over later this year. The Chemistry Department is not to move into the new building but is profoundly affected by its opening.

The Department is divided into Pure Chemistry, Industrial Chemistry, and Metallurgy with Glass Technology. In Metallurgy, the new iron and steel



General view of Iron and Steel Gallery



Part of Man-made Fibres Exhibit, showing historical specimens and apparatus incorporated in modern display

gallery was opened in 1958, with the help of the British Iron and Steel Federation. The industrial chemistry gallery already has new exhibits on plastics; oils, fats and soap; petroleum; tar distillation; rubber; man-made fibres; and dyes, with many more on the way, each subsidized by a branch of the chemical industry.

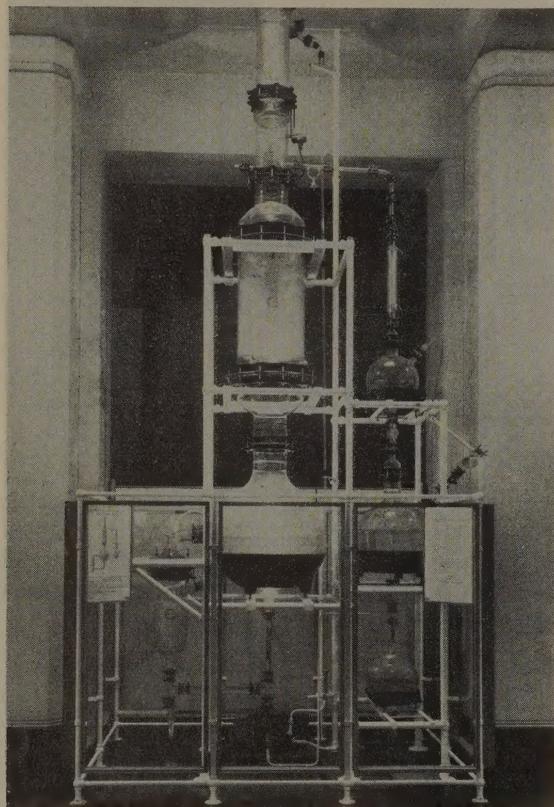
Pure Chemistry has been represented hitherto by an ill-assorted collection of exhibits: some objects of the greatest possible historical value, and some of great technical interest, but not fitting into any very logical scheme. It was decided to take advantage of the opportunity for reorganization to make the Pure Chemistry section illustrate the fundamental concepts and techniques underlying all the other aspects of chemistry, so far, that is to say, as could be done within the general exhibition policy of the Museum. The space available for Pure Chemistry is therefore to be increased by some 200 per cent, that is to about 10,000 square feet.

Before explaining how this space is to be used, something needs to be said about administration. The Science Museum is administered by the Ministry of Education. The Museum building is maintained by the Ministry of Works. Well over half-a-million pounds is being spent on the new building. Industry does not contribute financially to the routine maintenance of the Museum, but has always played an important part

by providing exhibits or funds for the preparation of exhibits. This industrial aid has sometimes been on a very generous scale. For example, the iron and steel industry, the gas industry and the electric power industry have each contributed in recent years sums of about £50,000 to £70,000 for the complete reorganization of the relevant galleries.

If the industrial chemistry gallery is to be completed, and if the new pure chemistry gallery is to be set up in comparable style, comparable aid will be needed. Some firms in the chemical and scientific instrument industries have already shown a great deal of interest. Donations have reached the £30,000 mark, and promises of material aid in the form of gifts of apparatus and equipment represent many thousands of pounds more. There is every prospect that the chemical industry will eventually match other industries in its support for the Museum. It is not easy to say which kinds of gift are most welcome. The Museum is already rich in historical and specialized collections in chemistry but, even so, interests need to widen greatly, and many of the collections need bringing up to date with examples relating to the great developments of the twentieth century. Apparatus now out of date, but marking the beginning of what was at the time a new method or process, is as welcome as the latest model of some instrument now standard.

It is impossible to treat the whole history and scope of chemistry in a Museum collection. Much of its development falls in the realm of *ideas* rather than *things* and would therefore be excluded even if there



All-glass industrial absorption apparatus

were unlimited space. It has therefore been decided to concentrate on those aspects of chemistry which can be illustrated by means of apparatus, or can be interpreted through visual or mechanical analogies (e.g. valency, molecular structure), or which exhibit distinct visual effects (e.g. indicators, photochemistry).

Whatever the material, it has to be displayed, and that is where a good deal of the money goes.

It is very easy to treat a museum as if it were a repository of material to be brought out on demand as a mere aid to elementary teaching. Certainly services to teaching can play an important part in the work of museums, but these services are at their best when they are easing the path of teacher and pupil to the understanding of the unique aspects of museum collections.

A museum is a home for the physical evidence of history and the physical products of creative endeavour. Even the most recent material has historical antecedents, and is itself antecedent to the yet unknown

work of tomorrow. Every paper in a scientific periodical describing new research is in a way a historical essay. It assesses the work done in the past; it presents some new estimate of theory or technique; and it points the way to new investigations. So a gallery in a museum of science, arranged as its curator's individual interpretation of his subject, surveys the past, states the present, and prepares for the continual admission of new work of the future.

It is with this outlook that the planning of the Pure Chemistry collection has been carried out. The first thing to settle was the overall scope. The Museum already possessed collections of outstanding interest 'by reason of the researches in which, or the persons by whom, they had been employed' to quote the Committee on Scientific Instruction of 1874. There were some of the few remaining relics of Dalton, specimens prepared by Faraday, Crookes, Kipping and others, the diffusion apparatus of Graham, the rare gas apparatus of Rayleigh and Ramsay, and Hampson's air liquefier. In recent years it has acquired molecular models used by Wollaston in 1812 and molecular models constructed for Dorothy Hodgkin in her recent work on vitamin B<sub>12</sub>.

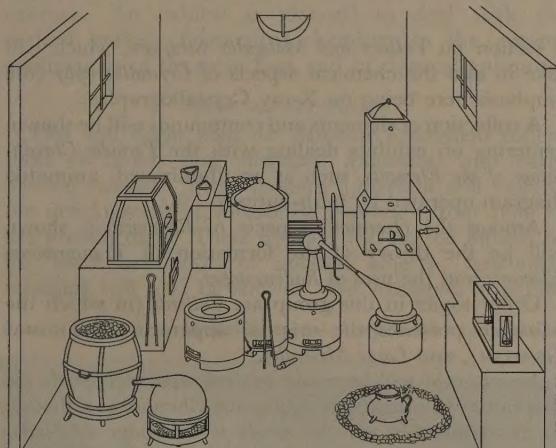


Faraday's portable laboratory, containing original chemical specimens in the open drawers

These unique objects have to be the foundation of any expanded scheme. After a good deal of reflection the following principle was accepted as a general guide. The two poles of chemical thought are (1) the chemist's theory of the constitution of matter and (2) the methods he uses for determining the constitution of a particular specimen or a typical specimen of a substance. Priority would be given to these determining features of the science.

One consequence was a decision to allot a very substantial space to analytical chemistry, not only through its principles but also through the means of its practice. There was kept in mind the aim of setting up a well-equipped working laboratory as a full-sized exhibit. When the exact space allotted to the collections could be settled, it became obvious that not only would it be possible to show modern laboratory practice in a realistic setting, but also the chemistry of earlier periods. In fact two other laboratories are to be built for which authentic information is available, one based on a number of textbooks of between 1795 and 1805, which contain dimensioned drawings from which accurate reproductions can be made.

It was debated whether to show a laboratory emphasizing the place of alchemy in the history of chemistry. It was decided, however, to profit from the studies which have been made in recent years of the work of the metallurgical chemists of the sixteenth century to build a laboratory which would represent commercial chemical practice of that period. Lazarus Ercker's *Treatise on Ores and Assaying* of 1574 contains enough detail to make it possible to reconstruct a complete assayer's laboratory, such as would have operated in the mining areas of Central Europe, at a



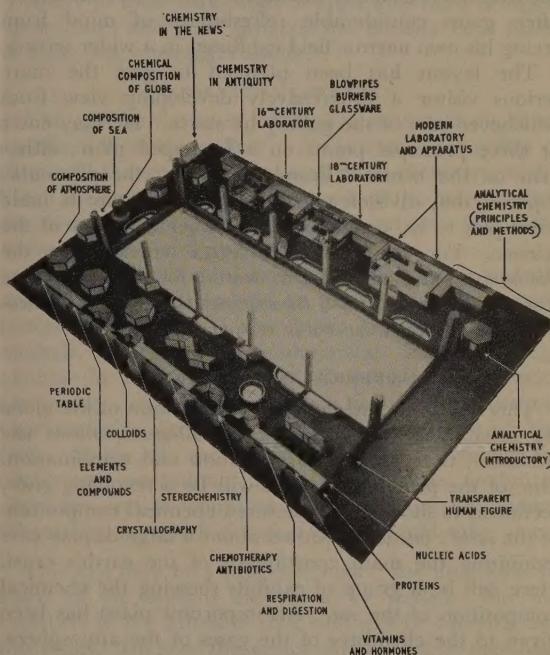
Proposed museum exhibit: full-sized sixteenth-century style assayer's laboratory based on Ercker

time when chemistry was taking its first steps towards becoming a modern science.

One other policy decision was taken: to allow Biochemistry its rightful position and the opportunity for expansion. To anyone unacquainted with the hard realities of Museum administration this might seem an inescapable decision but, in the face of staff shortage and what was then an uncertain financial position, there had to be second and third thoughts before the word could be given to develop what was virtually a new collection, when the older ones were still in need

of expansion. The topics selected for treatment have been mainly those linking biochemistry with organic synthesis and determination of structure, but the policy of an essentially historical treatment demands that studies of metabolism (as far back as the classic work of Lavoisier) be exhibited.

There is no one way to lay out a collection; indeed the despairing curator, bedevilled by the complexities



View of general layout proposed for Pure Chemistry Gallery

of cross-reference, sometimes feels there is never a right way. (Is pH measurement to be shown under *Electrochemistry* or under *Analytical chemistry*?—What is the best way of linking enzymes with catalysis without duplication?—and so on.) The plan worked out was inevitably a compromise, but it should be remembered that the visitor who works his way systematically through a collection as he would work through a textbook is rare, and is unlikely to rely solely on the collection to learn about the subject it deals with. The average visitor moves about at random. It is almost more important, therefore, to make certain that each exhibit (which may be one big object, or several smaller ones) should be displayed, lighted, labelled and explained by diagrams so as to present information which is complete and of value in itself. Nevertheless, a systematic arrangement is approached as closely as possible.

#### LAYOUT

The layout will fall roughly into three divisions, each of which will have one or two principal exhibits

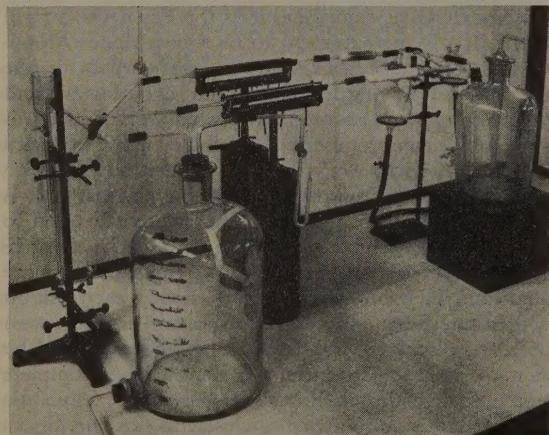
illustrating its theme. The many individual objects will mainly be treated historically, even where it is possible only to point a contrast between one early example and one of the most recent. Naturally the historical range will vary from the two or three thousand years of distillation to the few decades of the analytical mass-spectrometer or antibiotics.

The method of display envisaged is aimed mainly at the average reasonably intelligent visitor, but the expert often gains considerable refreshment of mind from seeing his own narrow field exhibited in a wider setting.

The layout has been planned to give the more serious visitor a progressively developing view from whichever part of the gallery he starts. He may enter at three principal points on a U-shaped plan: either arm or the centre. From each point the particular topic of that division will be developed from its basic principles to its connexion with other branches of the science. For example, the visitor entering at the *Biochemistry* end of the arm would follow a sequence from an introduction to *Biochemistry* through to *Applications of analytical chemistry in everyday life*.

#### CHEMICAL CONSTITUTION

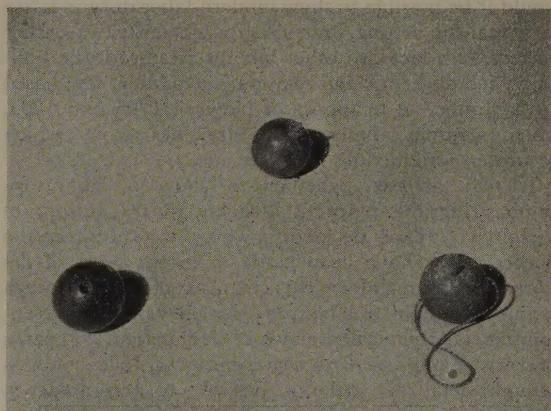
This will show the chemical composition of the globe we inhabit, and the theories of *Elements*, *Atoms* and *Molecules*, their states of aggregation and combination. One of the principal exhibits will be a revolving *globe*, sectioned to show the conjectured chemical composition of the *earth's interior*, mounted about a large display case exhibiting the main constituents of the earth's crust. Here will be a group of exhibits showing the chemical composition of the *sea*. An important place has been given to the chemistry of the gases of the atmosphere. The historical apparatus of RAYLEIGH and RAMSAY



Apparatus used by Ramsay for preparation of argon

would find a prominent place, but it is intended to show current lines of research in fair detail as well.

The sequence here can be thought of as following the ancient classification of Earth, Air, Fire and Water, with the historic eighteenth-century researches on combustion (PRIESTLEY, CAVENDISH, LAVOISIER) marking the foundation of modern chemistry. Some of DALTON's original material is in the Museum and will introduce



Dalton's atomic models: the last survivors of the balls which Dalton used to expound his atomic theory

a section on *Valency and Molecular Structure*, which will take in also the chemical aspects of *Crystallography* (the emphasis here being on X-ray Crystallography).

A collection of elements and compounds will be shown, centering on exhibits dealing with the *Periodic Classification of the Elements*, such as an illuminated, animated diagram operated by push-buttons.

Among the chemical aspects of *Radioactivity* shown will be the theory of the formation of *Transuranium Elements* and the uses of *Radioisotopes*.

Other topics in this group are *Colloids* (in which the Museum possesses the original apparatus of THOMAS GRAHAM), and *Large Molecules*.

No attempt will be made to deal separately with the descriptive ramifications of Organic Chemistry, although its fundamentals will be dealt with under *Molecular Structures* as an extended illustration of the special valency relations of carbon. (*Stereochemistry*, for example, belongs here.) A number of important groups of organic compounds are dealt with in the adjacent gallery devoted to Industrial Chemistry, but there will also be a number in Pure Chemistry in the division of *Biochemistry*.

This is the second chief division and, as explained above, is a new departure for the Museum. The treatment here cannot be comprehensive but it is hoped to do justice to topics in which British investigators have played a notable part as well as showing the chemical constitution of substances characteristic of living organisms, with *Hormones* and *Vitamins*, *Nucleic Acids*,

*Chemotherapy and Antibiotics*, as well as an important exhibit on the chemistry underlying food technology.

The third division will deal with practical chemistry or *Chemistry in the Laboratory*.

#### PRACTICAL CHEMISTRY

This will include Early Historical Chemistry, Chemical Apparatus and Analytical Chemistry. These will be unified by the series of three full-sized laboratories which will be the most conspicuous feature of the whole gallery. They will be supplemented by small-scale models of the laboratories of some famous investigators (e.g. CRONSTEDT, MOND).

The first and second laboratories can be reconstructed from historical information. The modern laboratory will be constructed and equipped to designs which are being agreed upon between the laboratory manufacturers, scientific instrument manufacturers and the Museum staff, their common aim being to make it represent, in its furnishing, its apparatus and its instruments all that is best in modern British chemical laboratory practice.

#### EARLY HISTORICAL CHEMISTRY

This will show the Museum's collection of alchemical apparatus, prints and engravings up to the eighteenth century. An exhibit is planned to deal with the earliest period of practical chemistry in the ancient civilizations of the near East and in classical antiquity.

#### CHEMICAL APPARATUS

This will begin with the Museum's excellent collections of *burners* and *blowpipes*, *hydrometers* and early *chemical balances*. More modern apparatus will include the development of volumetric glassware from 1830 to the present day. These displays will not be limited to the mere exhibition of isolated objects: functional relations will also be shown. For example, attention

will be drawn to the influence of improvements in methods of assembling apparatus as the traditional lutes were replaced by rubber tubing, and this in its turn was supplemented by totally enclosed glass apparatus and by standard ground joints. Considerable importance is attached to laboratory resources, commonly taken for granted but nevertheless significant in the development of chemical technique.

Many of these collections of apparatus need bringing up to date; and good progress has already been made in some (e.g. chemical balances).

#### ANALYTICAL CHEMISTRY

This will be the most substantial section of the three on this side of the gallery. An introductory group of cases will show the place of analytical chemistry in the life of the community (e.g. the work of the *public analyst*, the *forensic analyst* and so forth), in industry (e.g. *water treatment control*) and in research.

Some basic operations (e.g. elementary organic analysis) lend themselves to particularly instructive historical treatment. The main groups will divide analysis into various fundamental categories, e.g. analysis by the measurement of optical characteristics (*polarimetry*, *spectrography* and so forth) and electrical characteristics (*pH measurement*, *polarography* and the like). Some of the apparatus can be shown in continuous operation. The whole of the analytical chemistry section would be summed up in the modern laboratory, in which demonstrations could take place.

This can only be a progress report; the final form of many of the exhibits has yet to be settled. But the members of the Museum staff who will be carrying out this project will need the advice of many fellow-members of the profession. This article is published with the confidence that once they know what is being attempted they will be ready to help.

Miniature model: conjectural reconstruction of laboratory in which Cronstedt discovered nickel



(All illustrations: Science Museum, Crown copyright.)

# RAMAN SPECTRA

By JOHN ROSE, M.Sc., PH.D., F.R.I.C.

Senior Lecturer in Physical Chemistry, Birkenhead Technical College

## PART II

Having dealt in Part I (J., 83) with the general aspects of the Raman effect and with some applications in the field of molecular structure of organic compounds, I will now discuss inorganic and analytical applications.

### INORGANIC SOLID CRYSTALS AND RAMAN SPECTRA

Structures of salt hydrates have been investigated in some detail by means of their Raman spectra. For example, Raman evidence shows that in barium nitrate monohydrate the water molecule is only loosely held in the crystal, since the Raman shift of the solid compound is identical with that of water vapour.<sup>52</sup> Other crystalline solids investigated are the hydrates of the sulphates of nickel and manganese,<sup>53</sup> lithium hydroxide monohydrate<sup>54</sup> and antimony trichloride,<sup>55</sup> as well as single crystals, e.g. potassium and ammonium thiocyanates.<sup>56</sup> In the latter case, the Raman spectra lead to results in satisfactory agreement with those obtained by X-ray diffraction analysis. In addition, Raman evidence indicates the presence of hydrogen bonds in ammonium thiocyanate and some deformation of the ammonium ion in the compound. It is interesting to note that the Raman study of single crystals is not confined to inorganic compounds.<sup>57</sup> In general, infrared and Raman techniques are used for the elucidation of structures of inorganic salts and their hydrates. The latter show<sup>58</sup> one or two discrete O—H stretching bands between 3,150 and 3,636 cm.<sup>-1</sup>

The structures of carbon dioxide, ammonia and sulphur dioxide have been investigated in aqueous solutions.<sup>59</sup> The vibrational Raman spectra of the dioxides in aqueous solution are similar to those of the gaseous dioxides. There is, however, a slight frequency shift for ammonia on passing from its aqueous solution to the pure gaseous phase because of hydrogen bonding. There is no Raman evidence for the existence of carbonic acid, sulphurous acid or ammonium hydroxide.

In addition to these inorganic compounds, a large number of substances have been studied, ranging from solid para-hydrogen<sup>60</sup> to glasses. An extensive review of the Raman spectra of silica glasses appeared in 1958.<sup>61</sup> An important summary of recent developments in the inorganic field is given by Woodward.<sup>107</sup>

### RAMAN SPECTRA IN CO-ORDINATION CHEMISTRY

Raman scattering has been found to be of some use for the elucidation of structures and the evaluation of

force constants of bonds in complex inorganic compounds, though the colours of many inorganic co-ordination complexes introduce great experimental difficulties. The formation of complex ions can be verified by Raman spectra, e.g. Raman spectra of aqueous solutions of mercuric cyanide in the presence of an excess of sodium cyanide indicate<sup>62</sup> the formation of the complex ion  $[\text{Hg}(\text{CN})_4]^{2-}$ . Similar considerations apply to complex formation in aqueous solutions of cadmium and mercury halides, where complex negative halide ions are formed.<sup>63</sup> Indeed, it has been possible to follow the extraction of indium bromide by methyl isobutyl ketone from aqueous solutions of the indium salts by measuring<sup>64</sup> the intensities of the lines attributed to  $[\text{InBr}_4]^-$ . Krishnamurti<sup>65</sup> found that the Raman shifts of both solid ammonium tetrachloromercurate and aqueous solutions of mercuric chloride and ammonium chloride, where the salts are mixed in 1:2 molar ratio, are nearly the same, so that complex formation probably occurs in the solution, the ion being  $[\text{HgCl}_4]^{2-}$ . Other compounds studied by this technique are dibenzene-chromium and its cation,<sup>66</sup> potassium cuprotetra-cyanide,<sup>67</sup> complexes formed by mixing aqueous solutions of mercuric and potassium bromides,<sup>68</sup> and some very complicated structures, e.g. di-( $\pi$ -cyclopentadienyl-iron)tetracarbonyl in pyridine and ethanolic chloroform solutions.<sup>69</sup> For this compound there appears to be a structural change on dissolving the complex, since the solid is centro-symmetric, unlike the solute in pyridine.

An extensive study of complex formation has been carried out by Mathieu and Cornevin.<sup>70</sup> They found that complexes of metals which have similar structures and bond types yield similar Raman shifts. The latter can be classified into two groups: (i) those arising from metal-to-ligand bonds, and (ii) those having characteristic values corresponding to co-ordinated groups. The presence of metallic ions in solution generally lowers the value of the Raman shift. For example, the olefin shift is lowered by  $65 \text{ cm}^{-1}$ , and that of acetylene by about  $100 \text{ cm}^{-1}$ , in the presence of argentous, cuprous, mercuric or platinous ions.<sup>71</sup> The subject of metal complexes with unsaturated hydrocarbons has also been studied by Nesmeyanov.<sup>72</sup>

Raman spectra have been found to be of great value for the study of the stereochemistry of complex compounds. A large number of compounds have been investigated, e.g. ammines of platinum and rhodium<sup>73</sup>; telluric acid, chromates, molybdates, tungstates, chlorates

and bromates<sup>74</sup>; nickel carbonyl<sup>75</sup>; and azide ion.<sup>74</sup> It has been found that, in general, there is no positive difference in the Raman spectrum between square and octahedral configurations of the ammines of the platinum metals. The linearity of the azide ion, the pyramidal structure of the halate ions, the tetrahedral configuration of the chromate ion and nickel carbonyl have been confirmed by the characteristic Raman shifts, while octahedral symmetry has been assigned to the anion of telluric acid,  $H_6[TeO_6]$ . The Raman spectrum of sulphuric acid has received great attention.<sup>76</sup> The presence of the hydrogen sulphate ion in sulphuric acid has been confirmed by the characteristic Raman shift, while the addition of sulphur trioxide to the acid gave rise to Raman lines of disulphuric and trisulphuric acids. This problem is also considered at great length by Young *et al.*<sup>77</sup>

#### STRUCTURE OF ELECTROLYTIC SOLUTIONS

The type of the Raman spectrum, *i.e.* number of lines, polarization, isotopic changes, relation to infrared spectra and so on, can determine the nature and sometimes the identity of the species, while the ratio of integrated intensities of a strong Raman line in two solutions is often equal to the ratio of the concentrations of the solutes.<sup>78</sup> For example, perchloric acid in water gives rise to four lines owing to the tetrahedral symmetry of the penta-atomic anion.<sup>79</sup> On the other hand, perchloric acid yields seven Raman lines different from the four shifts of the anion. It follows that the presence of the seven acid shifts in the Raman spectra of concentrated solutions of perchloric acid would indicate a decrease in dissociation in solution. In fact, the intensity of the perchlorate lines may be taken as a measure of dissociation in perchloric acid solutions.

Mineral acids have been extensively investigated by studying their Raman spectra. A fundamental paper by Chédin<sup>80</sup> deals with nitric acid. The compound is found to be dissociated at concentrations less than 23.4 molar, the degree of dissociation being measured by the integrated intensity of the  $1,049\text{ cm}^{-1}$  line. At a concentration of 23.4 molar there is no dissociation at all. It is interesting to note, however, that the  $1,049\text{ cm}^{-1}$  line increases in intensity for the acid in the range 23.40–23.85 (100 per cent) molar, while a new line at  $1,394\text{ cm}^{-1}$ , corresponding to  $\text{NO}_2^+$ , makes its appearance. (This line is given by solid dinitrogen pentoxide and its solution in anhydrous nitric acid.<sup>81</sup>) The dissociation curve drawn by means of Raman data is similar to that obtained by the use of nuclear magnetic resonance.<sup>82</sup> Similarly, mixtures of electrolytes and their activity coefficients, structures of fused salts,<sup>83</sup> concentrated sulphuric acid<sup>77</sup> and other related topics have been studied by the Raman technique.

Force constants of co-ordinate links in complex compounds have been determined by means of Raman spectra by assuming that the strongest lines correspond

with the 'symmetrical breathing frequency' of the complex.<sup>84</sup> The force constants for typical co-ordinate links are rather smaller than those for single bonds, though of the same order of magnitude. Since the values of the force constants may be regarded as a measure of the work necessary to break the link, the calculated values of the mean restoring forces, *i.e.* force constants, should be proportional to the heats of dissociation of the links. This has been found to be roughly in accordance with observation.

#### ANALYTICAL APPLICATIONS OF RAMAN SPECTRA

The application of Raman spectra to qualitative analysis is based on the same principles as the use of spectrophotometric methods in the infra-red, visible and ultra-violet regions of the spectrum. Each molecule has its own Raman effect, irrespective of any other compound present, provided that no chemical reaction occurs in the mixture. In this respect it is somewhat superior to other spectroscopic methods, though fluorescent, coloured and photosensitive samples are difficult to handle without special methods (*see* below). The analyses can be carried out on small amounts of material in various states of aggregation, though solutions are preferred, especially in water. A great deal of information can be obtained from a Raman spectrum of a single substance or mixture. For example, the comparison of the spectrum of an unknown substance with those of other similar substances may establish the identity of the material. If, however, the material is completely unknown, and no similar substances are available for spectral comparison, then the spectrum can show the presence or absence of various groups of atoms or links, and thus lead to a determination of essential parts of the structure. For instance, Woodward verified the structure of the mercurous ion in aqueous solution<sup>108</sup> by noting the presence of a frequency due to the  $\text{Hg}_{2+}^{2+}$  species, since the univalent  $\text{Hg}^+$  species could give no vibrational Raman effect. On the other hand, the argentous and thallous ions are not present in the double form.<sup>109</sup> Furthermore, impurities may be detected in various substances. For example, it is possible to detect less than 0.5 per cent of styrene in ethylbenzene,<sup>110</sup> or 3 per cent of propylene in cyclopropane. Pyridine in various solvents can be detected<sup>105</sup> down to  $10^{-2}$  mole/l, while as little as 1 p.p.m. of *NN*-dimethyl-*p*-nitroaniline in methanol could be found by means of the  $\text{NO}_2$  Raman line at about  $1,300\text{ cm}^{-1}$  by using the Raman resonance effect.<sup>111</sup> For mixtures, comparison of their spectra with those of substances conceivably present in the unknown sample can assist in the identification of various components. In this connection Tables of Group Frequencies and systematic catalogues of spectra are of great importance.<sup>85,106</sup>

The analytical use of Raman spectra in the quantitative field depends on the assumption that the intensity of Raman lines of a component in a given volume of

a mixture is linearly proportional to the number of molecules of that component present (*cf. J. 84*). This principle applies to multi-component mixtures, although it is essential to test it for each type of mixture studied, since the spectral intensity of a solute line may be different in different molecular environments (internal-field effect).<sup>104</sup> It is, of course, necessary to establish that no chemical reaction occurs between the components. This is achieved by examining the spectrum of the mixture. If the Raman spectrum is a superimposition of those of the various components, it is safe to assume that no chemical reaction has occurred. This conclusion can be checked by quantitative spectroscopic study of standard mixtures. The procedure consists in determining the Raman spectra of the unknown material for various excitation frequencies and comparing these with those measured for various standard samples under identical conditions. It is thus possible, at least in principle, to analyse a mixture of  $n$  components by determining the intensities at  $n$  wavelengths and solving the set of simultaneous linear equations, relating intensity of lines to fractional composition.

Another difficulty encountered in practice is the fluctuation in the light source. This complication can be eliminated by using an internal standard in the mixture, usually carbon tetrachloride, a relatively unreactive substance which has a simple and strong Raman spectrum. The intensities of the Raman lines of the sample are then measured with respect to the line  $458.4 \text{ cm}^{-1}$ , which serves as an intensity standard,<sup>86,106</sup> the ratio of the intensity of a Raman band at the maximum to that of the  $458.4 \text{ cm}^{-1}$  line being known as the scattering coefficient; both lines must, of course, be measured under identical conditions and suitably corrected for polarization effects. The internal standard serves to eliminate other external variables, such as slit widths, sizes of the scattering tubes, filters, photographic and photoelectric responses. For quantitative analysis one has to consider other factors as well. Thus the intensities of Raman lines are affected by the nature of the solvents used,<sup>87</sup> pressure,<sup>88</sup> temperature,<sup>89</sup> optical activity of the substance,<sup>90</sup> external electric fields<sup>91</sup> and other factors. It must also be noted that photographic procedures are unsatisfactory for measuring intensities of Raman lines, since the blackening of a line is not proportional to its intensity, and some lines widen rapidly with concentration, so that there is less blackening for the same energy input than in a narrow line. The use of calibration graphs would not improve matters, for a change in the shape of a Raman line would introduce an error which cannot be eliminated.<sup>92</sup> A photoelectric Raman spectrometer is thus essential.<sup>93</sup> The integrated intensity measured by this instrument has been found to be proportional to the concentration of the molecular species,<sup>94</sup> though a correction has to be made in certain cases for the design

and position of the Raman tube. Special procedures have to be used in the case of overlapping bands,<sup>94</sup> the most common one consisting of drawing a vertical line through the Raman line and determining its half-area. This technique is satisfactory, provided that the foot of the interfering line does not extend beyond the peak of the line to be measured.

Despite the above-mentioned drawbacks and complications, the Raman effect has tremendous potentialities in the field of quantitative analysis. The introduction of photoelectric spectrometers of great speed and accuracy, direct mechanical modulation of source radiation,<sup>95</sup> resonance Raman effect,<sup>96,112</sup> microwave sources<sup>112</sup> and other improvements have increased the usefulness of the Raman spectra to a considerable extent. Inherently, the Raman effect offers great possibilities for an accurate, rapid and easy analysis of multi-component systems that are troublesome with infra-red or other spectroscopic methods.

#### APPENDIX

##### The Theory of the Raman-Smekal Effect

Incident radiation, represented by an electric field  $F$ , induces a dipole moment  $\mu$  in the molecules, the induced moment being proportional to the applied field, *viz.*

$$\mu = \alpha F \quad \dots \dots \dots \dots \dots \quad (1)$$

where  $\alpha$ , the proportionality constant, is known as the polarizability and is given by the relation

$$\alpha = \alpha_0 + \Delta\alpha \quad \dots \dots \dots \dots \dots \quad (2)$$

where  $\alpha_0$  is the value of  $\alpha$  for fixed nuclei, *i.e.* when nuclei do not contribute to scattering, and  $\Delta\alpha$  is the change in  $\alpha$  resulting from the displacement of the nuclei. If the nuclei of the molecule all move in phase so that a normal vibration occurs with a frequency  $\nu_r$ , then

$$\alpha = \alpha_0 + \Delta\alpha \cos(2\pi\nu_r t + \epsilon) \quad \dots \dots \quad (3)$$

where  $\epsilon$  is an arbitrary phase factor.

If there is no displacement of the nuclei, the classical theory of light leads to the relation

$$\begin{aligned} \mu &= \alpha F \\ &= \alpha F_0 \cos 2\pi\nu t \quad \dots \dots \dots \dots \quad (4) \end{aligned}$$

where  $\nu$  is the frequency of light ( $\text{sec}^{-1}$ ) corresponding to the electric field  $F$ . Hence

$$\begin{aligned} \mu &= \alpha F_0 \cos 2\pi\nu t \\ &= \alpha_0 F_0 \cos 2\pi\nu t + \Delta\alpha F_0 [\cos(2\pi\nu_r t + \epsilon)] \quad (5) \end{aligned}$$

It follows that

$$\mu = \alpha_0 F_0 \cos 2\pi\nu t + \frac{\Delta\alpha F_0}{2} \left\{ \cos [2\pi(\nu + \nu_r)t + \epsilon] + \cos [2\pi(\nu - \nu_r)t - \epsilon] \right\} \quad (6)$$

It is clear from equation (6) that the system will re-emit light of frequency  $(\nu + \nu_r)$  in addition to that of frequency  $\nu$ . The new  $(\nu + \nu_r)$  frequency (Anti-Stokes)

and  $(\nu - \nu_r)$  frequency (Stokes) will be incoherent because of the arbitrary phase factor  $\epsilon$ . Furthermore, quantum-mechanical treatment<sup>101</sup> shows that the absolute intensities of these new frequencies depend on the square of the integral

$$\int \psi_{00}(\Delta\alpha_{ij})\psi_{0v} \, dv \quad \dots \quad \dots \quad \dots \quad \dots \quad (7)$$

where  $\psi_{00}$  and  $\psi_{0v}$  are vibrational wave-functions (subscripts 00 and 0v refer to the non-vibrational level of the normal electronic state and to the normal state with one quantum of vibration, respectively), and  $\Delta\alpha_{ij}$  is the component of  $\Delta\alpha$  for a given transition probability. This component is given approximately by the expression

$$(\Delta\alpha_{ij})_{00} \approx \frac{1}{hc} \sum \frac{\nu_{0e} M_{0e}^i M_{0e}^j}{\nu_{0e}^2 - \nu^2} \quad \dots \quad \dots \quad (8)$$

where  $M_{0e}$  is the average dipole moment,  $\nu$  is the incident frequency, and  $\nu_{0e}$  is that of the electronic level above a normal state. The value of the component is zero unless there exists at least one excited state for which the transition probabilities ( $0 \rightarrow e$  and  $e \rightarrow v$ ) are simultaneously different from zero. In other words, a vibrational Raman effect is produced provided that there exists one excited electronic state which is capable of combining optically with the two levels of the normal state which differ by one quantum of radiation. It is to be noted, however, that the actual transition does not occur from state 0 to  $e$  and then to  $v$ , as in fluorescence.

The summation involved in equation (8) is very difficult and has not been attempted so far, since it is possible to obtain selection rules limiting the appearance of lines for given transitions by means of the transformation properties of wave-functions and  $\Delta\alpha_{ij}$ , when symmetry operations are performed on the molecule. Optical transitions are allowed or forbidden by the transformation properties of the wave-functions under symmetry operations. The study of symmetry operations is based on the Group Theory.<sup>113</sup> The latter has also been applied to the evaluation of force constants of molecules and radicals.<sup>113</sup>

In addition to the vibrational effect there is also a rotational Raman effect. Thus vibrational lines show a structure, more or less resolved; a fine structure also appears near the exciting frequency. The fine structure corresponds to pure rotational transitions, while the structure of vibrational lines represents a vibrational-rotational spectrum. It is difficult to observe a pure rotational spectrum owing to the breadth and intensity of the Rayleigh line, which has the same frequency as the exciting radiation. The intensity of this line may be reduced by interposing mercury vapour between Wood's tube and the spectrograph provided that the substance under consideration does not absorb at frequencies corresponding to those of the mercury lines. It is found that molecules with spherical symmetry do

not show rotational Raman spectra, *e.g.* carbon tetrachloride or sulphur hexachloride; linear molecules, on the other hand, show intense pure rotational spectra. It is interesting to note that linear molecules with a centre of symmetry, *e.g.* nitrogen, carbon dioxide and acetylene, show a rotational Raman effect, while pure rotational infra-red lines are absent. A recent development is the identification of individual rotational Raman lines for the asymmetrical-top molecules of ethylene and tetradeuteroethylene.<sup>102</sup>

A vibration-rotation spectrum arises when vibration and rotation are excited simultaneously, provided that the transitions are allowed by selection rules. Owing to the small magnitude of rotational quanta, rotation is fully excited at ordinary temperatures. For linear molecules, *e.g.* acetylene,<sup>97</sup> the broad Raman lines will show low intensity at the centre with maxima on both sides of the centre. This is usually the case when a vibrational angular momentum is different for the two vibrational levels connected by the transition. In symmetrical-top molecules the diffuseness of a Raman line points to unsymmetrical vibrations, while symmetrical molecules yield a sharp line. Totally symmetrical vibrations of spherical-top molecules lead to a sharp line, since the only transition possible is that corresponding to  $\Delta J = 0$ , as for example, in the case of methane or carbon tetrachloride, and other tetrahedral or octahedral structures.<sup>98</sup> For asymmetric-top molecules, *i.e.* those of most organic compounds, symmetrical vibrations lead to a sharp line, while non-totally symmetrical vibrations yield a diffuse line. The above considerations are of importance in the study of structures of molecules and polarization of the Raman scattering.

#### Polarization of Raman Lines

If a polarizing device, such as a Nicol prism, is placed in the beam of the scattered light emerging from a Raman spectrograph, then the lines are found to change in intensity with respect to the Rayleigh scattering and with respect to each other. The Raman lines are thus polarized, their state of polarization being described by the depolarization factor or ratio,  $\rho$ . This factor is given by the ratio of two intensities, called  $I_S$  and  $I_P$ , where the former refers to the intensity parallel to that of the incident light and the latter is that perpendicular to the direction of observation. This is shown in the schematic diagram (Fig. 3), where R is a point in the beam of the scattered light at which the Nicol prism is placed. For  $I_S$  the polarizing device is in the plane

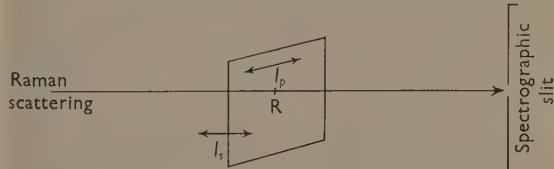


FIG. 3. Polarization of Raman spectra

of the figure, while for  $I_P$  it is perpendicular to that plane; in both cases it is perpendicular to the direction of the beam. When the incident radiation is unpolarized, the factor  $\rho_n$  takes a value for 0 to 0.857 for Raman scattering and 0 to 0.5 for Rayleigh scattering; in the latter case it is usually close to zero. The limiting value of 0.857 is attained when the Raman line corresponds to a non-totally symmetrical vibration; it is less than 0.857 for a totally symmetrical molecular vibration. In molecules having general elements of symmetry, totally symmetrical vibrations are few in number but they are readily recognized, since the depolarization factor is nearly zero, e.g. the totally symmetrical 'breathing' vibration of carbon tetrachloride at 458 cm<sup>-1</sup>. In simple molecules the depolarization ratio enables one to recognize totally symmetrical molecules, and the interpretation of many characteristic group vibrations in complex molecules, e.g. the C—H stretching vibration at 2,900 cm<sup>-1</sup> is based on such measurements.<sup>99</sup> Unfortunately, the determination of this factor is beset with experimental difficulties, since the insertion of a polarizing device and the use of baffles between the source and scattering tube for the production of a sharply directional beam of radiation reduces the intensity of the spectral lines. The accuracy and speed of the process can, however, be increased by the use of photoelectric recording spectrometers.<sup>100,103,106</sup>

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# Book Reviews

THE COMPLETE SCIENTIST: an inquiry into the problem of achieving breadth in the education at school or university of scientists, engineers and other technologists. Pp. xxiii + 162. London: Oxford University Press, 1961. Cloth 18s., paper 12s. 6d.

This important Report is the work of a distinguished Committee of Inquiry set up by the British Association for the Advancement of Science in 1958 under the chairmanship of Sir Patrick Linstead, F.R.S., Fellow, with a grant of £4,500 from the Leverhulme Trust Fund. Inquiry was made in detail of the main interested parties: headmasters; headmistresses; registrars and finance officers of university bodies; professors and heads of colleges; education officers of professional institutions and representatives of industry; chief officers of local education authorities; and the various Ministries concerned.

In future anyone venturing to talk on the liberal or humanities or general education of scientists and technologists (or even of the Complete Classicist) must first have studied this valuable report, if only to avoid the grosser errors and oversimplifications all too common in such discussions. Education at school and university is considered as a whole, with a view to possible changes at both levels, including the likely cost of implementing any proposals. The balance of general, literary and scientific education in the lower forms is thought to be satisfactory; but sixth-form work is too heavily specialized, and a doubling of the intra-curricular time devoted to non-scientific subjects would be more reasonable (though not necessarily wholly examinable). Great stress is laid on the function of the school in enabling its pupils to broaden their education at university. This is the traditional university attitude, and there are many signs of complacency in evidence given to the Committee. A comfortable reliance continues to be placed on the all-inclusive virtues of students' activities, halls of residence and voluntary attendance at college lectures. But an unhappy feeling is growing that the lectures mainly attract the converted minority, and that perhaps attendance ought to be a required voluntary activity; curiously these would still hardly be classifiable as 'intra-curricular non-scientific subjects.' The Committee thinks that such subjects should have only vocational relevance and be confined to 'the communication group—English and foreign languages.'

Management subjects must be postponed to the post-graduate stage, so that the great majority of those who enter industry will continue to be thrown into the six-foot end with only technological skills to help them. The Committee seems unaware that, at the under-graduate level, the aim is not to produce managers on graduation day but, through introductory social studies in the management and industrial field, to produce in the

future professional technologist an intelligent awareness of the non-technological factors on which his future work will greatly depend. The Committee's unawareness is consistent with its firm (though polite) exclusion of the relevant work of the colleges of advanced technology at the beginning of the Report—which is yet another sign of the continuing unfortunate dichotomy which exists in higher technological education in this country.

The Committee thus endeavours to relieve the pressure on undergraduate studies by placing great responsibilities on the schools, and by postponing certain studies and specialisms to the postgraduate stage. It considers some revisions of undergraduate syllabuses both desirable and feasible, but concludes that 'For the next 15 years, therefore, little if any modification of university courses in sciences and technology to allow more time for non-scientific interests can be expected.' This is because it thinks that a four-year undergraduate course, or even a less costly fourth postgraduate year for a minority, will not be feasible, mainly for reasons of planning and capital costs. Castles in the air indeed!

So the Report concludes with a careful consideration of 'Castles on the Ground,' which must first be given reality. Attention is thus focused on three cardinal problems—university entrance procedure, undue pressure on university places and quality in teaching at school. Altogether the Report is a sober and sobering document, in which adequate and varied data are carefully analysed, and recorded both in the text and the appendixes. But a fruitful synthesis will be far harder to achieve, and one may wonder whether this aspect is pursued vigorously enough, or put persuasively enough, to generate an educational conscience in the body politic commensurate with the need.

P. F. R. VENABLES

HETEROCYCLIC COMPOUNDS. VOLUME XIV.  
PYRIDINE AND ITS DERIVATIVES. Part 1.  
Edited by E. Klingsberg. Pp. x + 613. New York: Interscience Publishers Inc.; London: Interscience Publishers Ltd, 1960. 367s.

Pyridine is the most important of the heterocyclic compounds. It is typically aromatic and many of its properties closely follow those of benzene, but because of the heteroatom it also shows considerable differences in behaviour, and so the chemistry of pyridine is potentially more extensive than that of benzene. Fortunately for the reader and his pocket much less effort has been devoted to pyridine chemistry as yet, but even so it has been necessary to issue Volume XIV in four separate parts, and each is comparable in size to the larger of the previously issued single volumes of this Series. By no means incidentally, the huge task of editing the many and extensive contributions to Volume XIV has been assigned to Dr Erwin Klingsberg, of American Cyanamid.

Part 1 deserves much praise; it sets a very high standard. If the subsequent three parts match up to

this, then Volume XIV will become *the* authoritative source book on pyridine chemistry for some considerable time to come.

The book begins with a first-class chapter from R. A. Barnes of Rutgers (The State University, New Brunswick, New Jersey) on the properties and reactions of pyridine and its hydrogenated derivatives. After a short introduction, sufficient to put the subject into perspective and to set the scene historically, the fine structure of the pyridine ring is considered and compared with that of benzene. Comparison with benzene is extended to the physical properties, including spectroscopic data, and there follows a very readable account of the chemical reactivity. The influence upon the course of substitution reactions of the  $\pi$ -electron distribution, activation energies, atom localization energy and substituents are considered in turn, before attention is directed to examples of electrophilic, radical and nucleophilic substitution. The electron-donor properties of pyridine are next considered—its behaviour as a tertiary base, and ability to complex metals—and then oxidation, reduction, reactions with organometallics and ring-cleavage are described. The effects of the pyridine ring upon the properties of substituent groups receive attention, whilst a final section deals with di- and tetrahydropyridines. This chapter, including bibliography, occupies only 97 pages, so concise and clear is the style. A very complete account of pyridine chemistry is given in this compass, not merely in descriptive terms but with theoretical explanations and mechanistic interpretations. Few printer's errors have been noticed. There is, however, a chemical inconsistency which has escaped the editor. After the (correct) statement in Chapter 1, p. 78, that the reduced form of DPN contains a 1,4-dihydropyridine moiety, we see this same compound represented as a 1,2-dihydropyridine in Chapter 2, p. 103.

The second and much larger chapter (some 514 pages), by F. Brody and P. R. Ruby, of American Cyanamid, is devoted to a description of the natural sources of pyridine compounds and the many synthetic routes to the ring system, which are too numerous by far to adumbrate here. Again, the treatment of this vast topic is excellent, the presentation being concise, critical and most readable, whilst no attempt has been made to economize on graphic formulae or reaction schemes. The happy result is assisted by a considerable and intelligent use of tables.

J. A. ELVIDGE

AN INTRODUCTION TO BIOCHEMISTRY. E. O'F. Walsh. Pp. ix + 454. London: The English Universities Press Ltd, 1961. 27s. 6d.

There are several excellent textbooks of biochemistry available, but most of them are much too long or too expensive for junior students. While there is a serious shortage of biochemists, as at present, it is important to

have well-written, reasonably-priced books which present an introduction to the subject; such books should stimulate the student to undertake a more detailed study of biochemistry. Professor Walsh's book is not long—364 pages of text and 90 pages devoted to Appendix and Index—and it is reasonably priced. It is 'specially written for the student of biology, medicine or allied science, who is interested in the nature of life and whose curiosity or vocation demands that he devote some attention to biochemistry.' The mass of chemistry which often appears in the introductory chapters of many textbooks of biochemistry and which may deter many students has been omitted. Most of the chemical data required are included in the 'explanatory notes' in the Appendix. These notes are meant to stimulate memory, clarify doubts or remind the student that he should seek more detailed information elsewhere. It would have been helpful if some of the sources of information had been provided. Indeed, it is strange to find suggestions for further reading provided at the end of one chapter only.

The basic facts of biochemistry are presented in 14 chapters in a clear and interesting fashion. In addition to the usual titles, enzymes, metabolism of lipids, vitamins and so on, there are chapters on the role of phosphorus in the chemistry of life, enzymic activity in relation to biological adaptation and a short concluding chapter on applied biochemistry. Sometimes the simplification is overdone, as in the omission of coenzyme A from the flow sheet on p. 187. The appearance of 'Co A' in this diagram would not add much complication and would help to impress on the student's mind the importance of this substance in fatty-acid biosynthesis.

There are a number of serious mistakes in this book. The formulae of corticosterone and deoxycorticosterone (p. 204) are wrongly labelled. It is also quite wrong to say that corticosteroids which influence permeability to organic metabolites have oxygen at C-11 while those which affect electrolytes have no oxygen at this position. Aldosterone, the principal hormone influencing electrolytes, has a hydroxyl group at the 11-position.

The author warns in his preface that he will speculate a little and offer his own opinions at times. This is rather dangerous in an elementary book, especially when it is not always clearly stated what is fact and what is speculation.

Despite these criticisms I think that this book might be read with profit and interest by junior science students and that it may well stimulate them to find out more about biochemistry. It is probably less suitable for medical students who do not require to know about photosynthesis and plant hormones, but who might be expected to be provided with more information about such subjects as the digestion and absorption of fat or the maintenance of plasma pH.

J. K. GRANT

TRANSPORT AND ACCUMULATION IN BIOLOGICAL SYSTEMS. Second Edition. E. J. Harris. Pp. xi + 279. London: Butterworths Scientific Publications, 1960. 50s.

Most scientists who are interested in living matter encounter problems concerned with transport of ions or molecules from one phase to another. Thus, there are aspects of the passage of sugars from the gut to the blood stream which still mystify physiologists and many unsolved problems exist for botanists, relating to the absorption of mineral salts from soil by plants. The biochemist may be undecided as to whether a certain hormone exerts its action directly on a particular enzyme, or indirectly by increasing the permeability of cell membranes so that substrates may gain access to their enzymes more readily. Bacteriologists have often been misled in studies of compounds that, when incubated in respirometers with bacterial suspensions, were oxidized only very slowly: although the enzymes for oxidation were present inside the cells, the substrates were unable to reach them. In such cases the transport of the substrates to the cell interior is often controlled by enzymes which have been termed 'permeases'; but the fact that they have been named does not make their action any easier to visualize. It is no criticism of the present book to say that such systems as these are not discussed at any length, for, as Dr Harris points out in the introduction, there are enough problems connected with the transport of simple ions into cells to justify limiting the scope mainly to inorganic compounds.

This is the second edition of a book first published in 1956 and now largely re-written; the author himself has done distinguished experimental work in this field, notably in connexion with the exchange of ions between nerves, muscles or erythrocytes and surrounding fluids. The first four chapters contain general information about cells and the properties of solutions while the remaining eight chapters deal with some specialized properties of individual cells. In the earlier chapters the movement of materials through membranes is discussed, and a clear account is given of mechanisms which would explain the preferential passage of certain ions such as potassium. Studies with the electron microscope of the structure of cells and the particles inside them are beautifully illustrated with plates showing sections of muscles and nerves. From cell structure the author proceeds to a discussion of fluid movement and its connexion with diffusion, osmosis, electro-osmosis and other factors. One chapter deals with ion distribution, including the Donnan equilibrium and diffusion potentials, with development of the relevant mathematical equations. The chapters concerned with specialized cells and structures are excellent. They include accounts of ions in erythrocytes and muscle, passage of water and salts through amphibian skins, osmotic behaviour of mitochondria, the kidney and its functions, the gastric mucosa, the intestine and the eye.

The book is well produced and clearly written; and biologists, biochemists and biophysicists will find it stimulating. When the third edition appears one hopes that enough will be known about the so-called permeases to enable Dr Harris to discuss active transport of organic molecules as clearly as the passage of ions into various cells is discussed in the present edition.

S. DAGLEY

THE PHYSICO-CHEMICAL CONSTANTS OF BINARY SYSTEMS IN CONCENTRATED SOLUTIONS. VOLUME IV. Systems with Inorganic + Organic or Inorganic Compounds (Excepting Metallic Derivatives). J. Timmermans. Pp. xi + 1332. New York: Interscience Publishers Inc.; London: Interscience Publishers Ltd, 1960. 293s.

With the appearance of the fourth volume of Professor Timmermans' compilation the work as a whole is complete, since the present instalment provides the formula index and the bibliography for this and the three volumes which preceded it. More than two-thirds of the numerical data presented in the fourth volume relate to binary mixtures containing water; the rest are data on non-metallic + organic mixtures or mixtures of inorganic substances.

Sufficient was said about the general character of this reference text in notices of earlier volumes (Volume I, *J.*, 1959, 372; Volume II, *J.*, 1960, 18 and Volume III, *J.*, 1960, 175) and all that needs to be added is that Volume IV, as regards the tabulated physico-chemical data it contains, is quite similar in all respects to the earlier volumes, and is no more free from textual corruptions and obscurities.

As this work appears in an English dress an English reader must be allowed to protest at the pitifully inadequate editing of the text. 'Sulfur' and 'sulfate' we have learned to accept, but not 'gaz' nor 'atomes'; and why 'silicium' for 'silicon'? English surnames seem to have given trouble and are often wrongly transcribed—thus 'Wrightman' for Wightman, 'Dolian' for Dollar, 'Thomsen' for Thomson, 'Chibuall' for Chibnall, 'Phleps' for Phelps and so on. So also with Scottish names beginning with Mc or Mac; and an author of osmotic-pressure fame appears in the bibliography as 'E. G. I.' Hartley. This treatment of English names is not exceptional—'Wrewsky,' 'Vrevskii' and 'Wrevsky' are used indifferently in the text and bibliography for one and the same authority; and so also are 'Giguère' and 'Gignère.' These are minor blemishes, but occasionally something more serious is encountered; for example, there is no entry in the bibliography which can be recognized as referring to 'Silgardo and Starrow, 1950' on p. 193.

A user of this compendium will have to cope as best he can with corruptions or obscurities which could not be removed from the typescript prior to offset printing. These apart, the indexing system has other inherently

frustrating features. There is no subject index and in the formula index, although every page which contains any data relating to a particular substance is listed, the data themselves are not specified, and a specific piece of information can be found only by turning pages. For some substances, such as ethyl alcohol (274 scattered pages), this is not the work of a moment.

Although a considerable proportion of the data offered are inaccurate or have been superseded, Professor Timmermans has eschewed any critical evaluation except in a very few instances and then only to a limited extent. This volume contains data on the densities of aqueous solutions of sugar, alcohol and sulphuric acid which have been repeatedly redetermined and improved. In such instances to reprint figures which no one will ever use again was clearly unjustified. There is no doubt that much of the tabulated material in all four volumes would have been jettisoned if Timmermans had been able to harden his heart sooner (see Preface, p. v).

The cost of this work may place it beyond the reach of many libraries where it would be an essential, if at times an exasperating, tool.

E. A. COULSON

**PURE FOOD AND PURE FOOD LEGISLATION.** Edited by A. J. Amos. Pp. xii + 167. London: Butterworths, 1960. 21s.

The Pure Food Centenary Conference, which took place in London in September, 1960, was an outstandingly successful event. It provided an opportunity for those concerned with many aspects of the people's food supplies to meet together and to hear the views of leading workers in this field.

The opportunity was well taken, as will be seen from the record of the proceedings now published.

Dr J. H. Hamence spoke on the 1860 'Act for preventing the adulteration of articles of Food or Drink' and its influence, from the point of view of the analyst. Dr E. B. Hughes dealt with the manufacturers' contribution to pure food.

They were followed by Dr J. G. Malloch, Scientific Adviser to the High Commissioner for Canada, on pure food and the Commonwealth and Dr Norman C. Wright, Deputy Director General, F.A.O., who reviewed international aspects of pure food and pure food legislation.

National problems in Canada, Australia and the U.S.A. were described by Dr C. A. Morell, Professor F. H. Reuter and Dr G. P. Lerrick, respectively, and the final paper was given by Professor A. C. Frazer on the integration of food research.

With contributors of this calibre, the Conference was understandably a very valuable one. Now, for the benefit of those unable to attend it, the entire proceedings have been published in a compact volume, which includes, in addition to the main papers, a full report of the discussions which followed.

The editor, Dr A. J. Amos, is to be congratulated on the fullness of this record and the celerity with which it has appeared.

H. D. THORNTON

**SEWAGE TREATMENT. BASIC PRINCIPLES AND TRENDS.** R. L. Bolton and L. Klein. Pp. vii + 161. London: Butterworths, 1961. 30s.

This book is intended to give young assistants in sewage works, public-health inspectors and civil-engineering students an understanding of the principles of sewage purification. In so small a book the authors have done well in presenting a balanced account of such subjects as the chemical analysis of sewage, the systems in use for sewerage towns, sewage treatment by settlement and biological oxidation and the improvement of effluents, the disposal of sludge and the effects of trade effluents on treatment processes. A final section is devoted to trends in the methods of purifying sewage.

Five pages are devoted to the chemistry and composition of sewage and the microbiological breakdown of its constituents by such processes as aerobic and anaerobic oxidation. The intended reader may find this section the most difficult to comprehend. A brief but useful account is given of the methods of chemical analysis of sewage and trade effluents and of the interpretation of the results of analysis.

Line drawings of proprietary plant are freely used. A description of the operation of such plant might be included in future editions as part of the diagram.

It is worth pointing out to students that sedimentation tanks can still be efficient even if they do not remove up to 90 per cent of the suspended matter; the efficiency obtainable depends upon the nature of the suspended matter. The authors might also state conditions under which 'percolating filters can gradually adjust themselves to concentrations of up to 30 to 40 p.p.m. [of CN] without any serious deterioration in the quality of the effluent from the sewage works.' The authors rightly point to the growing number of works producing effluents of exceptionally high quality. To their list of such works could be added others which were achieving similar standards many years before a High Court injunction resulted in Luton following suit.

The much-quoted velocities for screening and grit tanks of about  $1\frac{1}{2}$  ft/s are difficult to attain in small works; thus the flow of 20,000 gallons per 24 hours per ft<sup>2</sup> of screen mentioned on p. 41 is equivalent to only 0.04 ft/s. It is best to face the fact that unwanted matter will deposit in screen chambers and grit tanks, and make provision to remove it.

The student and, indeed, any chemist who wishes to familiarize himself with sewage purification processes will find this a most useful book, written in a fluent style.

S. H. JENKINS

THE CHEMISTRY AND TECHNOLOGY OF FERTILIZERS. A.C.S. Monograph No. 148. Edited by V. Sauchelli. Pp. x + 692. New York: Reinhold Publishing Corporation; London: Chapman & Hall Ltd, 1960. 144s.

The addition of inorganic fertilizers to the land in present quantities is a quite recent development, and the industry which provides these chemicals is thus of fairly recent growth. The literature and especially the textbooks and handbooks of fertilizer materials are sparse, and the appearance of this book should be examined as an event of considerable potential significance.

There are 24 chapters in the book, each self-contained and with separate bibliographies. The authors come mostly from the American industry with a few from its British counterpart. Five chapters deal with various aspects of phosphate rock, five with phosphoric acid and various manufactured phosphates, six with preparation of powder and granular mixed fertilizers, four with process problems in fertilizer manufacture; of the remainder, one covers nitrogen, one potash, one X-ray data of fertilizer materials and one liquid fertilizers. The treatment is varied, as is to be expected from a variety of writers; it is often essentially descriptive and concerned with commercially available processes.

I did not find the book particularly well balanced in subject material, and the contents did not entirely match up to the title. The book might be better styled 'Process Aspects of the Fertilizer Industry'—there is not a consistent attempt to describe the essential chemistry in terms of current conceptions.

The treatment of nitrogen is extremely disappointing; the physical chemistry of hydrogen production and ammonia synthesis are entirely omitted. There are instead long lists of U.S. ammonia plants. It would have been interesting to have comment on nitrogen fixation by radiation and by nitric oxide synthesis in flames. Methods of production of ammonium nitrate are briefly mentioned, but vital information of structure (polymorphism) and thermal reactivity is omitted. Ammonium sulphate is described in rather less than one page, about one-fifth of the space devoted to ureaforms! A number of urea manufacturing processes are described, but the chemistry of urea is neglected. There appears to be no mention of thermal condensation reactions of the type leading to biuret formation. It is stated that urea does not react with inorganic salts in mixed fertilizers, a statement at variance with the facts. There is no mention of the double salts formed between ammonium nitrate and ammonium sulphate, although the so-called sulphate-nitrate is of great significance in Europe. Similarly, Nitrochalk is entirely omitted. In a book dealing mainly with process aspects of fertilizers it seems strange that the methods of making both these nitrogenous top-dressings are omitted.

There is a much fuller treatment of the occurrence and processing of rock phosphates. However, the

section dealing with mining, washing and beneficiation relates entirely to American deposits, and non-American readers would appreciate an extension of the treatment to other deposits. Some information on non-American rocks is, however, given in the section on manufacture of normal superphosphate, which is given a full discussion occupying most of three chapters. The section on rock reactivity is comprehensive and clearly written.

The chapter on wet-process acid gives an elementary account of the principles of manufacture and deals with six processes in current use. There is a considerable quantity of useful engineering data, but one would have liked to have seen a fuller discussion of the system considered from the reaction kinetic and reaction engineering aspects. The solvent extraction method of production developed in Israel is mentioned, but not described. Considered in relation to some of the omissions mentioned earlier, the 18 pages accorded to the preparation of diammonium phosphate from by-product ammonia and furnace acid seems excessive.

Three chapters deal with the production of granular mixed fertilizers, the emphasis being mainly on the T.V.A. process, the slurry process based on mono-ammonium phosphate, and nitrophosphates. Current American practice is well described, though the treatment of nitrophosphates is lacking in fundamental considerations. In view of the inherent neatness of these processes, they are perhaps wrongly placed under the heading 'Miscellaneous Phosphate Fertilizers.' Under this title is some discussion of metaphosphates and basic slag which, however, both appear also in the thermal processes chapter. There could have been better co-ordination of the contributions in this respect, and the treatment of basic slag is inadequate.

The chapter on potash is more balanced than some others in that a general statement on sources is attempted. The principles of recovery and upgrading are clearly explained, and it seems that a general, rather than a local, approach has been sought in the treatment.

The treatment of plant practices in the production of non-granular fertilizers is a very general one, and covers in an abbreviated fashion subjects that in the main are treated in other sections of the book.

The chapter on caking of mixed fertilizers will be of interest to all technologists, since this problem is encountered in all processes for granular compound manufacture to a greater or lesser extent. Although the knowledge of the fundamental physics and chemistry of the problem is limited, there is a vast technical and patent literature mostly describing new anticaking devices. This literature appears to be adequately covered.

Of basic importance in caking are the drying and cooling of granules and the crystallographic composition of the product materials—usually determined by X-ray diffraction. There are separate contributions on these

subjects. Drying and cooling are treated essentially from the plant-operation aspect, and there is no attempt to deal with them as rate processes.

The last chapters deal with materials of construction, handling and effluents; all are highly important to the operator, especially as regards the dominating part played by mechanical handling in production processes, the corrosive nature of fertilizer intermediates, and the unpleasant nature of some process effluents.

This book will undoubtedly be valuable as a guide to workers in the industry, but it cannot be regarded as giving the comprehensive coverage of subject matter which its terms of reference imply. With a more complete and balanced treatment and less overlapping between sections a more valuable work would surely have resulted. The price seems high, but may not be so, considering the subject and the experience involved.

J. R. ARTHUR

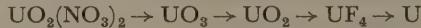
PROCESS CHEMISTRY. VOLUME III. PROGRESS IN NUCLEAR ENERGY SERIES III. Edited by F. R. Bruce, J. M. Fletcher and H. H. Hyman. Pp. vi + 474 + XII. Oxford: Pergamon Press, 1961. 105s.

The development of the chemical processes for the extraction of uranium from its ores and the preparation, on a large scale, of the pure metal or oxide for the fabrication of the fuel elements for nuclear reactors is one aspect of process chemistry in the nuclear energy field covered by the third volume of the Pergamon Press series. The extraction of plutonium from the irradiated fuel element and the recovery of uranium, sufficiently free from fission products to be used in further fuel cycles, forms the greater part of the volume. Other papers deal with the disposal of the radioactive wastes arising from these processes. The book also includes a summary of the important papers presented to the Second International Conference on Peaceful Uses of Atomic Energy, and a related bibliography.

Chapter 1 is devoted to the extraction and concentration of uranium from ores, and E. A. Brown *et al.* describe the search for more economical methods based on improving the sulphuric acid leaching technique for ores requiring a high acid consumption. Useful data on the comparative purity of ion exchange and amine extraction are presented, although the section would be strengthened by reference to the forward extraction and scrub conditions used to prepare the amine solutions. A paper from Yugoslavia by Jonanović and Pacović describes a process for winning uranium from coal ashes by leaching with  $\text{Na}_2\text{CO}_3$ , but the economics of the process would appear to be such that, in the existing supply position, it is unlikely that the Coal Board will be supplying the raw material for the nuclear energy industry. Beverly and Charles describe pilot-plant studies on the alkaline leaching of ores followed by direct precipitation of  $\text{Na}_2\text{UO}_4$ . This paper is a concise guide to the development of a competitive process and will be

of interest to all workers in the field of uranium extraction. The recovery of the radioactive decay products of uranium, such as Ra, Pa,  $\text{Th}^{230}$ , from uranium ores is described by V. B. Shevchenko. The process utilizes precipitation, solvent extraction and a classical fractional crystallization of Ba and Ra chromates. The reader is reminded of the advantages of counter-current solvent extraction or selective ion-exchange techniques over the laborious recrystallization process.

Chapter 2 deals with the preparation of uranium metal and oxide for reactor use and  $\text{UF}_6$  for gaseous diffusion plants. The majority of the world's uranium metal plants use the route



and the differences are largely those of chemical engineering techniques. The reader is able to compare Swedish, Canadian and American practices. A paper by Thayer describes the newest American plant and is an excellent survey of all the important aspects of metal production, but the reader is not given any information on some of the difficulties to be encountered in the design of counter-current or co-current reduction and hydrofluorination stages.

The production of  $\text{UF}_6$  directly from ore concentrates by fluid bed and fractional distillation methods is described by Lawroski *et al.* This work is largely applicable to a plant designed to produce  $\text{UF}_6$ , and appears to be of lesser value if a combined process is used to give  $\text{UF}_4$  for metal production and  $\text{UF}_6$  for gaseous diffusion plants, as is the U.K. practice, although it may be of value if selected ore concentrates are available. The paper is to be commended for its references to difficulties encountered and overcome, and it summarizes a very large development programme.

Chapter 3 is devoted to the processing of irradiated uranium to separate the Pu and U from fission products and to recover the elements in a form suitable for re-fabrication. The earlier volumes in the series have dealt with much of the groundwork in this field, but the present volume is outstanding in its selection and presentation of the material; the reader can gain a sound view of the chemical and chemical engineering approach made by the U.S.A., U.K. and U.S.S.R. in the development of plants for the reprocessing of natural and enriched uranium fuels.

Brown *et al.* describe further progress made by the A.E.R.E. towards the understanding of the chemistry of Ru in solvent (particularly TBP) processes, and the paper demonstrates the usefulness of paper chromatography as an aid in following the behaviour of Ru on the plant. The paper includes a survey of work on the extraction of Zr and Nb with particular reference to degradation products of TBP. This work is of value in indicating the possible reasons for the failure of counter-current TBP processes to give decontamination factors for Zr, Nb and Ru comparable to those obtainable for

Ce, Cs and R.E. elements; the solution of this problem could lead to a single-cycle process with very large savings in plant and process costs.

Howells *et al.* review the British Butex process and give a clear and authoritative account of its chemistry and plant design philosophy. The paper well exemplifies the thesis that successful radiochemical plants demand sophisticated simplicity in both the process and plant. A valuable feature of the paper is the description of plant layout and the details of ancillary equipment.

Karraker describes a high-temperature scrub on the primary extractor of a TBP process and this, coupled with a heated U/Pu separation extractor gives an overall decontamination factor for Zr/Nb and Ru of  $\sim 10^6$  thus bringing a single-cycle process within the designers' grasp.

A paper of considerable interest is that from the U.S.S.R. by Schevenko *et al.* who describe the process for elements from the first U.S.S.R. power reactor. This utilizes U-Mo-Mg alloy fuels in stainless-steel cans. The dissolution takes place in the presence of  $\text{Fe}^{3+}$  or  $\text{PO}_4^{3-}$  to suppress the precipitation of Mo. The difficulties in radioactive waste storage when processing alloyed elements are lightly dismissed by accepting a low evaporation ratio for the waste stream. This is an unacceptable solution for a method designed to treat economically the fuel from a large nuclear power programme.

Vdorenko and Kovalskaia deal with a process based on a mixture of dibutyl ether and carbon tetrachloride, said to be explosion proof. The solvent density is said to be sufficiently low to permit its use in packed columns 'even without pulsation.' In my experience pulsation hinders and does not assist phase separation. It may be the poor quality of the translation, but this paper (particularly section 2) does not permit a detailed evaluation of the qualities of the selected solvent; the decontamination factors are not related to the extraction conditions used. On the whole the process described appears to be an early one, and does not compare with the U.K. and U.S. TBP processes used for U-Al alloys from materials-testing reactors, which appear to be the fuel feed referred to in the Russian paper. The translations of the Russian papers do not appear to have been revised by the editors; the clarity could have been greatly improved had this been done.

Cooper and Walling give a masterly review of progress in the American work in the field of aqueous reprocessing, covering the Purex, Thorex and enriched (DMTR) fuel processes, extraction of minor elements (Np and Am), the chemical and radiation degradation of solvent, and anion-exchange processes for the purification of Pu. Readers familiar with radiochemical processing will already be convinced of the value of this paper and the fact that it contains summaries of processes already described *in extenso* in the volume under review does not detract from its value. Indeed, it could well

have been the first paper in Chapter 3, to serve as an introduction to the remainder.

Chapter 4 deals with the pyrometallurgical reprocessing of irradiated uranium, in which the objective is to reduce the neutron-absorbing fission products to such a level that a reconstituted element may be used without further purification. This philosophy demands fully active plant for fuel-element fabrication.

The technique chosen for E.B.R.(II), melt-refining, is described by Burris *et al.* The fuel is simply held molten in a crucible and purification effected by the volatilization of noble gases, Cs and Ru and the selective oxidation of the electropositive elements, for example the rare earths. The oxides are removed by adherence to the crucible. This process appears attractive for simple fuel elements, such as those of E.B.R.(II), but the plant required for the side stream necessary to remove fission products which would otherwise build up, and that for the treatment of the active off-gases, is to be taken into account when comparisons are made with conventional processes yielding a product that can be refabricated under conditions of low activity.

Schraadt and Levenson describe several high-temperature processes under development in the U.S.A., based on melt refining, solvent extraction by molten metals, fractional crystallization and electro-refining. Further details are given by Feder and Tertel. These papers cover a field in which the U.S.A. is pre-eminent and in which a large amount of development work has been carried out. This work must have been economically justified, and it would be interesting for such processes to be costed against solvent extraction; the cost of remote fuel-element fabrication can easily be underestimated.

Chapter 5 deals with the disposal of radioactive waste from fuel reprocessing. Loeding *et al.* describe the fluidized-bed calcination of wastes, a process which yields a dry powder of  $\text{Al}_2\text{O}_3$  containing the fission products. The process is designed for waste from MTR reactors, which contains the aluminium present as an alloy in the fuel element.

This process is unlikely to compete with conventional storage for MTR wastes, which are of a small volume, but its development, by the addition of suitable calcining agents for the processing of wastes from natural U fuels, could be of value.

Blascutzz and Schmidt deal with the treatment of radioactive waste gases arising from radiochemical plants, and their description of the application of glass-fibre filters to the removal of aerosols from gases will be of interest to chemists outside the field of nuclear energy.

Chapter 6 is an excellent résumé by Bruce of the important Geneva papers, and is of value to the student new to the field of nuclear chemical technology.

Volume III of this series is the best of the Pergamon Press books dealing with the chemistry and technology

of nuclear chemical plants. The selection of material is sound, the presentation excellent and the bibliography indispensable to the serious worker in this field.

The editing of the large amount of information submitted to the Geneva Conference is a difficult task, and if the earlier volumes of this series could be criticized as being insufficiently selective, Volume III sets a pattern which may be confidently recommended for the future conferences.

B. F. WARNER

**FIRST PRINCIPLES OF CHEMISTRY.** M. D. Taylor. Pp. xxii + 688. Princeton: D. Van Nostrand Inc.; London: D. Van Nostrand Ltd, 1960. 56s.

The problem of teaching chemistry to those who have had no previous training on entering college is one which has exercised many minds, but it is of especial interest in the U.S.A. and other countries where less specialization occurs in the later years at school. On the other hand, any book of this kind must be of interest to our sixth-form chemistry masters since they are faced with similar problems, though the solutions to them may be quite different. It is well known that the S.M.A. and A.W.S.T. have recently published suggestions (*Chemistry for Grammar Schools*. London: John Murray (Publishers) Ltd, 1961) for the revision of our chemistry teaching in schools, and this in itself shows the great interest in this problem.

The criticism which has often been levelled at chemistry teaching is that by and large it is too factual, but the situation has changed rapidly in the past 20 years with the advance in theories of chemical bonding and a wider understanding of the basic physical principles of chemistry. Nowhere has this had greater effect than on the teaching of inorganic chemistry.

This is an American approach, and the author claims to use 'experimental findings as a means of developing fundamental theory, since experimental investigation is the source of most chemical knowledge.' This is a difficult assignment because it is the crux of the whole problem, and it is almost impossible to judge how successful the book would be without knowing the kind of experimental course with which it is associated.

After a short introduction to the basic mathematics for chemistry there are seven chapters on the physico-chemical principles of chemistry, with later chapters on reaction velocity and equilibrium; molecular structure, solid state; electrochemistry; and the colloidal state. The treatment of these topics is up to date, and the author has considered them from the point of view of a few basic principles, and stressed the importance of calculations for understanding of the subject matter.

From an almost classical discussion of the periodic classification the author leads on to chapters on 'the building stones of the atoms,' and 'the architecture of the atom' and these sections are a very good feature of the book. For the descriptive inorganic chemistry, the

subject matter is arranged under the following headings: oxygen, hydrogen and water; the halogens; the active metals; the chalogenes, *i.e.* ore-forming elements; nitrogen, phosphorus and arsenic; copper-zinc groups; boron, carbon and silicon; the transitional elements; the metalloids; and the inner transitional elements (rare earths). There has been a careful pruning of the information so that only the salient facts are given together with simple theoretical explanations, and included are topics such as chromatography, chelate compounds, boron hydrides and so on not usually mentioned in books at this level.

Organic chemists will feel that insufficient space has been given to this important branch of chemistry, but clearly the author has tried to treat carbon as one of the elements rather than as a specialized study. Nevertheless much information has been packed into the chapters entitled 'Organic Chemistry' and 'Natural and Synthetic Products.'

Many British teachers will want to see this well-produced book, and have it on the shelves of the library, but few will recommend it for use in sixth forms or intermediate classes, because it has been aimed to serve a different public.

F. H. POLLARD

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**CHARACTERISATION OF ORGANIC COMPOUNDS.** Second Edition, 1958, reprinted 1960. F. Wild. Pp. viii + 306. Cambridge: University Press. 18s. 6d.

**RESEARCH HIGHLIGHTS OF THE NATIONAL BUREAU OF STANDARDS. ANNUAL REPORT, FISCAL YEAR 1960.** National Bureau of Standards Miscellaneous Publication 237. Pp. vii + 189. Washington: U.S. Government Printing Office, 1960. 65c.

**BIOSYNTHESE UND STOFFWECHSELWIRKUNGEN DER SCHILDDRÜSENHORMONE.** (Biochemie und Klinik Monographien in Zwangloser Folge.) G. Hillmann. Pp. viii + 133. Stuttgart: Georg Thieme Verlag, 1961. DM 26.50.

**CLYDE RIVER PURIFICATION BOARD ANNUAL REPORT** (for the year ended 15th May, 1960). Pp. 43.

### BRITISH STANDARDS.

718: 1960. Specification for Density Hydrometers and Specific Gravity Hydrometers. Pp. 34. 10s. net.

Addendum No. 1 (1960) to 2690: 1956. Methods of Testing Water Used in Industry. Pp. 27. 6s. net.

(Obtainable from B.S.I., 2 Park Street, London, W.1.)

# Institute Affairs

## EXAMINATIONS, JUNE, 1961

### Graduate Membership, Part I

An examination for Graduate Membership, Part I, will be held on **Monday and Tuesday, 19 and 20 June, 1961**, in London and elsewhere at the discretion of the Council.

Entry forms will be sent as soon as they are ready to accepted candidates. **The last date for the return of Entry Forms will be Monday, 8 May, 1961.** No entry will be accepted if received after that date.

## EXAMINATIONS, SEPTEMBER, 1961

### Graduate Membership, Part II

Theoretical examinations will be held in London, Birmingham and Glasgow, and, if required, in other centres on **Monday and Tuesday, 11 and 12 September, 1961.**

Practical exercises will be carried out in London, and, subject to confirmation, in Birmingham and Glasgow on **Wednesday to Saturday, 13 to 16 September**, inclusive and in London on **Tuesday to Friday, 19 to 22 September**, inclusive.

Candidates will be asked to state their preference as to the centre for their theoretical papers and the period and centre for their practical exercises; but it must be clearly understood that no guarantee can be given that their wishes will be met.

Candidates who have not yet been accepted for examination and who wish to present themselves in September should obtain from the Assistant Registrar without delay the prescribed Application Form, so as to allow ample time for obtaining the necessary signatures certifying that they have complied with the Regulations concerning their courses of training. **The completed Application Form must reach the Institute not later than Monday, 5 June.** No application will be considered if received after that date.

Entry forms will be sent as soon as they are ready to all accepted candidates. **The last date for the receipt of Entry Forms is Monday, 3 July.** No entry will be accepted if received after that date.

## EXAMINATION RESULTS

### Diplomas in Applied Chemistry

*Examination in Branch D* : Clinical Chemistry  
*Examiners* : Professor E. J. King, Dr I. D. P. Wootton

The examination was held at the University of London Postgraduate Medical School, London, W.12, and at 30 Russell Square in the week beginning 13 February, 1961. There was 1 candidate, who passed.

*Examination in Branch E* : The Chemistry (including Microscopy) of Food, Drugs and Water

*Examiners* : Dr H. E. Archer, Mr T. McLachlan

The examination was held at the University of London Examinations Laboratory, Brunswick Square, London, and at 30 Russell Square in the week beginning 13 February, 1961. There were 6 candidates, of whom 3 passed.

## PASS LIST

### Branch D.

AHLQUIST, Keith Arthur, B.Sc. (ST AND.), A.R.I.C.

### Branch E.

BROWN, Geoffrey David, A.R.I.C.

HOLLAND, Geoffrey James, B.Sc. (LOND.), A.R.I.C.

KANDASAMY, Thambipillary, B.Sc. (CEYLON), A.R.I.C.

## INSTITUTE REPRESENTATION

**British Standards Institution.**—Dr Frank Hartley has been renominated as representative of the Institute on the Chemical Divisional Council for the session 1961-62.

Mr F. R. Whitt has been nominated to represent the Institute as well as the Institution of Chemical Engineers on a Committee that has been set up to prepare a code of practice on lining of tanks for chemical processes.

**United Kingdom Advisory Council on Education for Management.**—In January the Institute Council nominated Mr E. LeQ. Herbert, *President*, as representative of the Institute on this Advisory Council (J., 58), and has now nominated Mr H. A. Collinson to serve on the Joint Committee that has been established to administer the new Diploma in Management Studies in England and Wales and in Northern Ireland.

**Constantine Technical College.**—The Council has made the following nomination :

*Middlesbrough, Constantine Technical College: Chemical Advisory Committee* : Dr G. H. Mansfield, *Associate*, in succession to Dr R. G. J. Telfer, *Associate*.

## AWARDS

**Meldola Medal, 1960.**—The Council of the Institute, with the concurrence of the Society of Macca-baeans, has decided to award the Meldola Medal for 1960 to

John Newton BRADLEY, B.Sc., PH.D. (BIRM.), A.R.I.C. who is at present Lecturer in Inorganic and Physical Chemistry at the University of Liverpool.

A short biographical note of Dr Bradley will be published in the next issue of the *Journal*.

**Beilby Medal and Prize for 1961.**—The meeting of the Administrators to consider making an award from the Sir George Beilby Memorial Fund has been deferred until May, and no announcement is therefore to be expected until the June issue of the *Journal*.

**Council Meeting.**—It has been agreed that the first meeting of the Council after the Annual General Meeting should be held on Friday, 12 May, instead of on the normal date (a week later), which will be the Friday of Whitsun week-end.

**Proposed Licentiateship Grade.**—At their meeting on 17 March the Council considered first drafts of changes in the By-laws that will be required in order to establish the Licentiateship grade. It is hoped that resolutions to effect such amendments to the By-laws and to deal with other relevant matters will be ready for approval by the Council on 12 May, and for submission to a Special General Meeting to be held in London in June, *possibly* on Thursday, 15 June, at 6 p.m. Corporate members in Great Britain and Ireland will, in any event, receive due notice of the date, time and place of the Special General Meeting, with particulars of the resolutions and explanatory notes.

In the meantime the Institute's Study Group on Qualifications is giving detailed consideration to conditions of admission to Licentiateship, and has already made two interim reports to the Council. When the review by the Study Group has been completed, it will be for the Council in due course to promulgate regulations for admission to Licentiateship. It will be appreciated, however, that this cannot be done unless and until the requisite changes in By-laws have been approved by corporate members in General Meeting, and allowed by the Privy Council.

**Recognition of Colleges.**—The following colleges have been granted provisional recognition for the training of students to the Part I level of the Graduate Membership examination:

*Croydon Technical College.*

*Mid-Cheshire Central College of Further Education, Northwich.*

The Liaison Officers will be Dr S. R. Robinson, *Fellow*, and Mr D. E. Craimer, *Fellow*, Heads of the respective Departments of Science.

**Presentation to Dr William Honneyman.**—At a recent Annual General Meeting of the Belfast and District Section a presentation was made to Dr William Honneyman in recognition of his outstanding services to the Section and to the profession of chemistry in Northern Ireland. As an officer or member of the Section Committee during the past 37 years Dr Honneyman has been

closely associated with many important developments, and has done much to promote the interests of his fellow chemists.

With characteristic generosity he has decided that the presentation, which was in the form of a cheque for a substantial sum, should be passed to the Benevolent Fund. The Chairman and members of the Benevolent Fund Committee gratefully acknowledge this further evidence of his interest in the work of the Fund.

## PERSONAL NOTES

### Societies and Institutions

Dr D. W. Kent-Jones, *Past President*, has been made an Honorary Member of the American Association of Cereal Chemists. This is a new distinction, and it has been conferred at the same time on four cereal chemists in the U.S.A. and one in Canada. All six were previously ordinary members of the Association.

Professor K. Ramamurti, *Fellow*, is the first Indian to have been elected a Member of the Institute of Biology.

**Institute of Fuel.**—The Council of the Institute of Fuel has re-elected Dr H. E. Crossley, *Associate*, Hon. Secretary for the fifth time. Mr G. Nonhebel, *Fellow*, was elected a Vice-President, to take office this month.

**Royal Society.**—The following have recently been elected to Fellowship of the Royal Society: Dr Joseph Chatt, *Fellow*, Dr George J. Popjak, *Fellow*, and Professor J. Baddiley, *Meldola Medallist* 1947.

**Royal Society of Edinburgh.**—The following have recently been elected to Fellowship of the Royal Society of Edinburgh: Dr R. C. Mackenzie, *Fellow*, and Professor P. L. Pauson, *Fellow*.

### Consultants

Mr W. E. Ballard, *Fellow*, has retired as executive director, Metallisation Ltd, and will be undertaking consulting work in the field of industrial corrosion and protection. His address is 38 Grassmoor Road, King's Norton, Birmingham, 30.

Mr W. Gordon Carey, *Fellow*, has recently retired from his position of chemist and bacteriologist to the Sunderland and South Shields Water Company, an appointment he has held for some 40 years. His retirement will enable him to give more time to his work as Public Analyst and water consultant.

Mr J. A. Radley, *Fellow*, reports that his consulting practice has been registered as a limited company under the title of J. A. Radley (Laboratories) Ltd. The analytical, technological and development services of the practice will be supplied by this company, but the sponsored and pure research work has been taken over by the newly formed J. A. Radley Research Institute, also at 220-222 Elgar Road, Reading, Berks.

Dr John White, *Fellow*, has now resigned his full-time industrial appointment and established a practice as an independent consultant scientist to the food and fermentation industries at 23 Meadow Hill Road, King's Norton, Birmingham, 30 (Tele: King's Norton 2747).

### Educational

Dr M. F. Lappert, *Fellow*, at present lecturer in chemistry, Faculty of Technology, University of Manchester, has been appointed senior lecturer in chemistry as from 1 October.

Mr T. L. MacDonald, *Associate*, was recently appointed an Assistant Professor at the University College of Addis Ababa, Ethiopia.

Dr S. Skidmore, *Fellow*, has been appointed Vice-Principal of the Harris College, Preston. He was formerly head of the department of chemistry and biology at the College.

Dr G. Tolley, *Fellow*, head of the research and experimental department of Allied Founders Ltd, has been appointed principal of the Victoria Institute College of Further Education.

### Public and Industrial

Mr E. H. M. Badger, *Fellow*, has been appointed senior research chemist at the London Research Station of the Gas Council.

Mr R. M. Brachi, *Associate*, has taken up a post with Murray, Sons & Co. Ltd, Whitehall Tobacco Factory, Belfast.

Mr E. A. Burfoot, *Fellow*, has been appointed works director of Riker Laboratories Ltd, Loughborough, Leicestershire.

Mr D. K. Coutts, *Associate*, managing director of the Nickel Information Bureau Pty Ltd, Melbourne, is visiting the U.K., Europe, America and Canada in the period April to August. Letters should be addressed c/o The International Nickel Co. (Mond) Ltd, Thames House, Millbank, London, S.W.1.

Mr J. E. Cummins, *Fellow*, has returned to the head office of the C.S.I.R.O. in Melbourne, having completed approximately three years' service on secondment to the International Atomic Energy Agency, Vienna, where he was director of the division of scientific and technical information.

Dr E. R. H. Davies, *Fellow*, of Imperial Chemical Industries Ltd, Fibres Division, Harrogate, is now overseas technical manager.

Mr J. M. Dougary, *Fellow*, formerly head of the operating services group, Kuwait Oil Co. Ltd, has now returned to the company's London offices.

Dr N. A. C. Friend, *Fellow*, has been appointed European technical manager by the Canadian Chemical Co. Ltd, with effect from 1 February. He will work from London.

Mr J. Hadfield, *Fellow*, who has been managing director of Derbyshire Stone Ltd since it commenced trading in 1936 and chairman since 1945, has relinquished the office of managing director and become executive chairman, as from 28 February.

Mr G. Halek, *Associate*, has been appointed works manager of Kemball, Bishop & Co. Ltd, a member of the Pfizer Group. He was previously head of organic production at the Sandwich plant of Pfizer Ltd.

Mr J. D. Howie, *Fellow*, left Karachi on 22 March on conclusion of his tour of duty under the Technical Co-operation Scheme of the Colombo Plan. Communications may now be addressed to him c/o The Civil Service Club.

Mr W. Hunter, *Fellow*, has been appointed a director of British Celanese Ltd.

Mr L. G. W. Palethorpe, *Fellow*, has taken up the post of manager, heat treatment furnace division, Salem-Brosius (England) Ltd, Milford, Nr Derby. He was formerly with Wild-Barfield Electric Furnaces Ltd, Watford.

Dr H. L. Richardson, *Fellow*, head of the agricultural overseas section, Imperial Chemical Industries Ltd, Billingham Division, and President of the Fertilizer Society, has been seconded for two years to the Food and Agriculture Organization of the United Nations in Rome, as project manager of the Fertilizer Programme. (This is a world-wide scheme, financed by the fertilizer industry as a contribution to the Freedom from Hunger Campaign, which aims at increasing food production in the under-developed countries by demonstrating the effective use of fertilizers.)

Mr A. W. Starey, *Fellow*, technical adviser to Glaxo-Allenburys (Australia) Pty Ltd, will arrive in this country on 6 June for a visit of several months to the U.K. and the Continent. Communications should be addressed c/o E.S.A. Bank, 8-12 Brook Street, London, W.1.

Dr R. N. C. Strain, *Fellow*, has been appointed superintendent of the chemical physics department, National Gas Turbine Establishment, Ministry of Aviation.

Mr B. White, *Fellow*, managing director of A. Boake, Roberts & Co. (Holding) Ltd and its main subsidiary, A. Boake, Roberts & Co. Ltd, has been appointed chairman of the two companies, with effect from 1 April.

Mr T. P. Whitehead, *Fellow*, has been appointed head of the department of biochemistry, Queen Elizabeth Hospital, Birmingham.

Dr T. D. Whittet, *Fellow*, chief pharmacist, University College Hospital, London, has been awarded a World Health Organization Fellowship that is taking him on a six-week visit to study hospital organization in Oslo, Stockholm, Gothenburg, Malmö, Copenhagen, Bonn, Paris and The Hague, from 8 April. The Fellowship is designed to provide opportunities not available in the holder's own country for training and study in health matters. Dr Whittet is the first British pharmacist to be granted the Fellowship.

# Section Activities

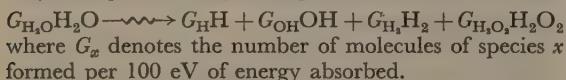
## BELFAST AND DISTRICT

*Annual Dinner.* The Joint Annual Dinner of the Belfast and District Sections of the Royal Institute of Chemistry, the Society of Chemical Industry, the Chemical Society and the Andrews Club of Queen's University was held on 27 January in the Great Hall of the University. Mr K. L. Robinson, Chairman of the Belfast Section of the S.C.I., presided, and the guest of honour was Mr T. Gilbert Webb, Chairman of the Dublin Section of the S.C.I. Professor C. Kemball made a presentation to Dr W. Honneyman, who had been in office continuously in this Section of the Institute since 1924—a unique record of service.

*Radiation Chemistry.* On 23 February Professor F. S. Dainton, F.R.S., gave a lecture entitled 'The Principles of Radiation Chemistry and the Possibilities of its Industrial Application.' Professor Kemball presided at the meeting, which was held in the Chemistry Lecture Theatre of Queen's University.

Professor Dainton defined radiation chemistry as chemical change induced by the absorption of energy from high-energy photons ( $X$ - and  $\gamma$ -rays) or fast charged particles, for example  $\alpha$ -particles, protons, deuterons and so on. In all cases the incident charged particle or the secondary electron from photoelectric absorption or Compton scattering of an  $X$ - or  $\gamma$ -ray loses energy by inelastic energy transfer to orbital electrons of the molecules of the medium.

Isolated excited and ionized molecules and groups of these  $\delta$ -rays or spurs are thereby formed in the wake of the particle in a linear 'concentration' proportional to the linear energy transfer (L.E.T.), which is larger the lower the energy and the greater the mass of the particle. In a liquid system, about  $10^{-13}$  sec after the passage of the particle the ion and excited molecules have generally disappeared and been replaced by free radicals having the same non-uniform distribution;  $10^{-7}$  sec later the radicals have either combined to 'molecular' products or diffused away from their cylindrical or spherical volume elements and become accessible to solutes with which they can react. Thus in the case of water the situation may be represented by the equation:



The kinetic consequences of this (that is, indirect action) were illustrated by reference to the observed changes when aqueous solutions are irradiated and the results used to show the relation of various  $G_x$  values to the L.E.T. of the system.

Possible applications to medicine, biology and chemical industry were shown to depend on the fact that ionizing radiation enables primary species, notably ions

and radicals, to be produced at any temperature in any phase in translucent or opaque materials at controlled rates. Examples of radiation-induced low-temperature processes and room-temperature radical processes in organic systems, including grafting and cross-linking of polymers, were cited.

After answering many questions from the audience, Professor Dainton was thanked by the Chairman.

*Careers in Chemistry.* About 80 grammar school teachers attended a meeting on 'Careers in Chemistry,' sponsored by the Section, at Queen's University on 3 March. Professor Kemball was Chairman of a panel consisting of Mr D. G. Chisman, Education Officer of the Institute, Mr E. A. Cooke, Imperial Chemical Industries Ltd, Mr E. T. Hutt, Shell Research Ltd, Mr J. P. Parke, Unilever Ltd and Dr A. J. Howard, Director of the Department of Industrial and Forensic Science in Northern Ireland.

Each panel member, in a short talk, outlined the opportunities for chemists in his particular field; the meeting was then opened for general discussion and questions. A lively and useful interchange of views ensued. Professor Kemball thanked the panel.

## GLASGOW AND WEST OF SCOTLAND

*The Genetic Effects of Atomic Radiation.* At a meeting in the Royal College of Science and Technology, Glasgow, on 10 February, the lecturer was Professor A. R. Gemmell, Professor of Biology in the University College of North Staffordshire. Dr W. A. Caldwell, Section Chairman, presided.

Professor Gemmell began by saying that it was well established that any ionizing radiation will cause gene mutation, and considerable anxiety had arisen about the future of mankind when in addition to normal background radiation from rocks, radon and so forth, he was subjected to the radiation produced by atomic explosions.

The basic difficulty in the study of the effects of atomic radiation was the lack of data on human subjects, but by extrapolating knowledge gained in experiments on *Drosophila* and mice and making the most pessimistic assumptions it was clear that the anxiety was exaggerated. Thus, if it were assumed that all mutations were due to radiation, then the additional radiation produced by fall-out would only increase the mutation rate by 1 per cent, while medical radiology contributed about 15 per cent.

The lecturer noted that evidence was accumulating which showed that chronic low rates of irradiation produced fewer mutations than had been previously supposed. He stressed, however, that all radiation will cause mutation, and in the absolute sense this 'was a bad thing,' but viewed in perspective the danger was very much less than was commonly supposed.

After questions, Professor P. L. Pauson proposed the vote of thanks.

*Ion Exchange.* On 24 February a joint meeting of the Section with the Scottish Section of the Society for Analytical Chemistry was held in the Royal College of Science and Technology, Glasgow. Mr A. F. Williams, Chairman of the Scottish Section of the S.A.C., took the Chair for the evening and introduced the two lecturers, Mr R. A. Wells and Mr V. E. Gripp.

Mr Wells gave the first lecture, 'Applications of Ion Exchange in Inorganic Analytical Chemistry,' and began by outlining the synthesis and fundamental properties of ion-exchange resins. He then discussed the equilibria and kinetics of ion exchange in the context of inorganic analytical chemistry. The various ways in which the analyst might employ ion exchange were illustrated with examples, and the lecturer concluded with references to modified cellulose exchangers, liquid ion exchangers and selective resins.

Mr Gripp spoke on 'Ion Exchange in the Electroplating Industry,' and reviewed the industrial use of ion exchange. He stated that the process had found extensive use in the metal-finishing trade from two entirely different standpoints, namely, the purification of metal treatment liquors, for example chrome anodizing baths, and the decontamination of emergent swill waters from metal finishing shops. The economic advantages arising from the application of the technique to both problems was dealt with in some detail by reference to specific cases.

After questions, Professor P. D. Ritchie proposed the vote of thanks.

#### HUDDERSFIELD

On the evening of 1 March, members of the Section visited the works of Yorkshire Imperial Metals Ltd at Leeds. The visitors were welcomed by Dr P. T. Gilbert, chief metallurgist, and by Mr J. W. Spence, of the Personnel Department, and were conducted round the works in three parties by Messrs R. Allchurch, G. Tetley and R. K. Turton, of the laboratory staff.

The foundry was visited first, and the party saw the operation of induction furnaces for the production of billets of various alloys and also the semi-continuous casting of aluminium brass. Next, billets were seen being made into shells by hot-press extrusion and by piercing. These were then converted to tubes by automatic cold-drawing machinery and into long lengths of small diameter tubes on vertical bull block machines. For special purposes, tubes were re-coiled and measured on automatic electronically-operated equipment, and in some cases were subjected to internal cleaning, inert-gas annealing and sealing. The manufacture of a variety of non-ferrous metal fittings was also seen.

In the laboratories, the visitors were shown the use of optical spectrographs recording on 35 mm film for the rapid analysis of alloy ingredients and impurities. Major ingredients were also determined rapidly by an X-ray spectrometer. Normal chemical-analysis methods

were described in the chemical laboratory, and in the Metallography Section there was a demonstration of metal defects. Service corrosion tests of various alloys under user conditions with appropriate water samples were also seen in a laboratory set aside for this purpose.

At the end of the tour, Mr G. M. Harrison expressed the appreciation of the visitors to their hosts.

#### HULL AND DISTRICT

*Spectrochemical Analysis.* On 23 February Dr T. S. Harrison, of the Appleby-Frodingham Steel Company, gave a lecture on 'Spectrochemical Analysis of Iron and Steel and Associated Materials,' at the North Lindsey Technical College, Scunthorpe.

The lecturer reviewed the work of Kirchhoff, Bunsen and Ångström in this field during the early part of the nineteenth century, leading up to the work of Barker in Sheffield relating to the use of spectroscopy in iron and steel analysis. Slides were shown illustrating simple spectrometers and development up to the present quartz spectrographs. The optical system and photographs of the Littrow Spectrograph were also shown. The method of using this instrument was briefly discussed, including the checking of the density of lines on photo-negatives and the use of calibration graphs with standard materials. Examples of analytical figures obtained by spectrographical methods were shown alongside results obtained by the conventional chemical methods.

After Dr Harrison's lecture, two senior spectrographers of the Appleby-Frodingham Steel Company gave short talks on two particular instruments. Mr Stamp described the Quantovac in some detail, including the method of operation, and Mr Hawke gave a corresponding talk on the Quantometer, with particular reference to the use of this instrument for slag analysis. Both talks were illustrated with excellent slides.

The meeting concluded with the showing of a colour film prepared by Dr Harrison on the use of the Quantovac and Quantometer. Many exhibits were available for inspection, including excitation units.

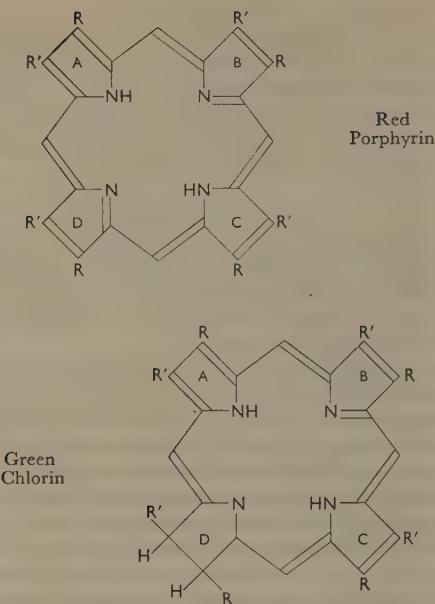
The vote of thanks was given by Mr G. Colman Green.

#### MID-SOUTHERN COUNTIES

*The Porphyrin Group of Natural Pigments.* On 10 February a meeting was held jointly with the University Chemical Society at the University of Southampton. Professor A. W. Johnson, of the University of Nottingham, gave a lecture entitled 'The Porphyrin Group of Natural Pigments.'

He commenced by dividing the porphyrins into two general classes, the red porphyrin, *e.g.* haemin, and the green chlorins, *e.g.* chlorophyll (see formulae at head of next page).

The groups R' were usually short groups, for example methyl, and the groups R long groups such as  $-\text{CH}_2\text{CH}_2\text{COOH}$ . Hans Fischer's work in Munich was described, especially the synthesis of haemin. A



new approach to the porphyrins was the development of methods based on the biogenesis pattern. By using labelled succinic acid and  $\delta$ -amino laeluvinic acid biogenetic intermediate porphobilinogen had been detected, and this was shown to form a macro ring by a chemical mechanism which explained the reversal of the groups in ring D.

In 1960 two teams reported on the synthesis of chlorophyll, and both were described. The method of the Munich team involved a reduction of a porphyrin to a chlorin by using sodium and isoamyl alcohol, whereas the Harvard team used steric hindrance to bring about a rearrangement of a porphyrin to a chlorin.

Finally, Professor Johnson described Vitamin B<sub>12</sub>, which contained a corrin ring. The problems of synthesis were discussed, including an example of a partial synthesis.

After a spirited discussion the vote of thanks was proposed by Dr R. E. Parker.

*Trends in Polymer Developments.* On 8 March a meeting was held jointly with the Institution of the Rubber Industry at the Red Lion Hotel, Salisbury. Dr L. Mullins, of the Natural Rubber Producers Research Association, gave a lecture entitled 'Trends in Polymer Developments for the Rubber Industry.'

Dr Mullins commenced by outlining briefly the two main trends; first the development of tailor-made polymers for specialized demands, these being made in limited quantities, and secondly the general-purpose rubbers. In the synthetic rubber world the greatest advance in the general-purpose rubbers was the

development of stereoregular polymers, resulting in such compounds as *cis*-polyisoprene and *cis*-polybutadiene.

Next, the properties of rubber were examined, in particular hysteresis; this gives rubbers their strength, abrasion resistance, ozone resistance, fatigue and tear resistance but causes heat build-up and creep, and lowers their resistance to low temperatures.

The problems of processing polymers, the economic aspect of rubber manufacture and the chemical modification of natural rubber were all discussed. Dr Mullins gave some very effective and amusing demonstrations and answered many questions.

The vote of thanks was proposed by Mr D. M. Turner.

#### MADRAS

*Chemical Education in the U.S.A.* On 18 February a meeting of the Section was held at the Madras Medical College, when the Section Chairman, Professor S. V. Ananthakrishnan, presided. Mr N. Pitchandi, Hon. Secretary, welcomed the gathering and introduced the speaker for the evening, Dr Doris V. Stage, of the Women's Christian College, Madras. Dr Stage spoke on 'Recent Developments in Chemical Education in the United States,' and discussed the way in which various problems are being tackled.

*Film Evening.* Members and guests assembled at the Little Theatre of the United States Information Service, Madras, on 10 March to see a film entitled 'Automation—See It Now.' The audience was much interested to learn of the problems arising from the introduction of automation in factories and elsewhere. At the end of the film Mr Pitchandi proposed the vote of thanks.

*Chromatography and Electrophoresis.* On 11 March, Dr Ninan Verghese, Professor of Biochemistry, Madras Medical College, addressed a meeting on 'Chromatography and Electrophoresis in Clinical Medicine.' Dr Anantakrishnan presided. The lecture, held at the Madras Medical College, was attended by many members of the medical profession, besides members of the Section and other chemists.

Dr Verghese described how, by using paper electrophoresis and paper chromatography, the electrophoretic pattern of the serum proteins and the amino-acid composition of  $\gamma$ -globulin and albumin could be studied with 0.5 ml of serum from a case of Lymphogranuloma venereum (*J. Lab. clin. Med.*, 1957, **49**, 370-76). He showed how the  $\gamma$ -globulin in Lymphogranuloma venereum was synthesized at the expense of the amino acids ordinarily utilized for the synthesis of the albumin. He also described a method worked out in his department for rapidly desalting biological fluids for the chromatography of the amino acids. This consisted of extracting the residue obtained after evaporating the fluids over a water-bath with a mixture of phenol and butanol (3 : 2 v/v). This procedure extracted the

amino acids, leaving behind the salts and other interfering materials (*J. clin. Path.*, 1957, **10**, 104). Dr Verghese claimed that this method was very suitable for clinical laboratories dealing with many samples of biological fluids containing large amounts of salts and minute amounts of amino acids. He also described the methods used in his laboratory for the chromatography of homogentisic acid and its precursors in the urine, and the chromatography of the azobilirubin pigments, formed by the van den Berg reaction. He showed how paper electrophoresis was employed in studying proteinuria and the changes in the protein fractions in cerebro-spinal fluid.

The lecturer further explained how paper electrophoresis was used in the study of urinary porphyrins (*J. clin. Path.*, 1958, **2**, 191). The electrophoretic pattern of porphyrins in the urine immediately distinguish porphyrinuria from porphyria. The pattern also gives a rough idea of the relative concentrations of the individual isomers of the porphyrins in the sample of urine.

The lecture was illustrated with slides showing the chromatographic and electrophoretic patterns of amino acids and proteins, and coloured slides showing the red fluorescence of the porphyrins under ultra-violet light in the chromatograms and electrophoretograms.

Mr Pitchandi proposed the vote of thanks to Dr Verghese.

#### WESTERN INDIA

**Plastics.** On 20 December Professor N. R. Kamath, Professor and Head of the Department of Chemical Technology and Deputy Director, Indian Institute of Technology, Powai, Bombay, addressed the Section on 'Plastics—Prospect and Retrospect,' with Dr H. S. Mahal in the Chair. After a résumé of the important developments in the chemistry of plastics, he explained in detail the mechanism of vinyl polymerization. He gave a review of the Indian plastics industry as it is today, depending mostly on imported raw materials, and pointed out how Japan, from a comparatively insignificant position, has become the world's fourth largest producer of plastics during the last decade. Discussing the probable trends of consumption in India, he said he felt that the demand for PVC products might increase indefinitely; with the availability of petroleum refinery gases, there were definite prospects for the development of polypropylene, the lightest plastic material to be produced so far. Similarly, he indicated that with the development of carbonization industries thermoplastic products of high impact resistance, like the new poly-carbonates (based on phenol and phosgene), should find wide scope under Indian conditions.

**Works Visit.** A technical visit by members of the Section to the Soap Works and Research Laboratories

of Hindustan Lever Ltd, Bombay, was arranged on 24 December. The members were taken round the various sections of soap and glycerine plants by Dr G. S. Hattiangdi, chief research chemist, and Dr S. M. Patel, manager of laboratories. After the tour there was a detailed discussion on the suitability of different indigenous vegetable oils for the soap and hydrogenated oil industries.

**Film Evening.** By courtesy of the United States Information Service, Bombay, and Lederle Laboratories (India) Private Ltd, three documentary films, 'Man at the Doorway,' 'Radio Pharmaceuticals' and 'Challenge of the Atom,' were shown on 23 January.

**Forest Wealth.** Professor Puntambekar, Professor of Polymer Technology, University of Bombay, addressed members on 'Our Forest Wealth: its Use, Abuse and Scientific Development' on 9 February. Dr A. M. Tyabji was in the Chair. The lecturer pointed out the forest area is only 22 per cent of the country as against a desirable target of 33 per cent and that, in spite of all the factors like atmospheric temperature, humidity, distribution of rainfall and so on, favouring the growth of all types of vegetation in India, the march of the Indian desert has not been effectively checked. He referred to the importance of various major and minor forest products, and said that, guided by institutions such as the Forest Research Institute, Lac Research Institute, National Chemical Laboratories and other regional laboratories, the country should aim at the scientific development of the paper industry from waste wood and forest grass; the production of essential oils, fats and drying oils from forest seeds; the utilization of medicinal herbs and their correlation with modern medicine; and the development of vegetable dyes, resins, tanning materials and so on from the available forest wealth.

**Utilization of Coal Tar Pitch.** Professor A. N. Chistyakov, of the UNESCO Technical Assistance Mission, Indian Institute of Technology, Bombay, addressed members on 'Utilization of Coal-Tar Pitch for the Production of Electrode Pitch Coke' on 28 February. Dr H. S. Mahal was in the Chair.

After tracing the importance of the electrode coke industry, the lecturer mentioned the industrial methods available for obtaining hard pitch from soft pitch, and indicated the chemical changes taking place during the air-blowing of pitch. He described the methods adopted in the U.S.S.R. and U.S.A. for the carbonization of hard pitch. He stated that while industrial units are successfully working out the process, considerable research will have to be undertaken to clarify the chemistry of the air-blowing of pitch, the composition of pitch tar and the nature of the 'ready (electrode) coke.'

# News and Notes

## AWARDS

**Corday-Morgan Medal and Prize.**—The Council of the Chemical Society has awarded the Corday-Morgan Medal and Prize for 1959 to Dr A. R. Battersby, Lecturer in Chemistry at the University of Bristol, in consideration of his outstanding work on the stereochemistry of emetine and its congeners, and also his contributions to the chemistry of curare alkaloids and the biogenesis of papaverine.

This Award, consisting of a Silver Medal and a monetary Prize (which, for the year 1960, will be increased to 400 guineas), is made annually to the chemist of either sex and of British Nationality who, in the judgment of the Council of the Chemical Society, has published during the year in question the most meritorious contribution to experimental chemistry, and who has not, at the date of publication, attained the age of 36 years.

Copies of the rules governing the Award may be obtained from the General Secretary of the Chemical Society, Burlington House, London, W.1. Applications or recommendations in respect of the Award for the year 1960 must be received not later than 31 December, 1961, and applications for the Award for 1961 are due before the end of 1962.

**First International Palladium Medal.**—The American Section of the Société de Chimie Industrielle has announced that the first International Palladium Medal will be presented to M. Ernest-John Solvay, of Belgium, on 20 April. The Medal was established 'for the purpose of giving recognition to an individual whose efforts and dedicated service to international understanding and co-operation among individuals in the field of industrial chemistry have furthered the cause of the Société and benefited the industry as a whole.'

## EXHIBITIONS AND COURSES

**International Plastics Exhibition.**—The Sixth International Plastics Exhibition (INTERPLAS 61), organized for *British Plastics* and *International Plastics Engineering* by Iliffe Exhibitions Ltd, with the co-operation of the British Plastics Federation, will be held from 21 June to 1 July at Olympia. The International Plastics Convention, which will be held in conjunction with the exhibition on 26-28 June, will survey current technical and commercial progress in thermoplastics. Tickets and further information on the exhibition may be obtained from Iliffe Exhibitions Ltd, Dorset House, Stamford Street, London, S.E.1.

**Laboratory Apparatus and Materials.**—The second national Laboratory Apparatus and Materials

Exhibition, sponsored by *Laboratory Practice*, will be held in the Royal Horticultural Society's New Hall, Westminster, on 19-22 June. It is expected that every type of laboratory equipment, from Britain and overseas, will be shown and demonstrated. A special feature of the exhibition will be a series of 12 scientific lectures on recent advances in laboratory techniques. Subjects include radio-frequency methods in analytical chemistry, vapour-phase chromatography, biological assay of insecticides and the electron microscope in studies of protein synthesis.

**Nuclear Technology.**—A further one-year full-time postgraduate course in nuclear technology (chemical) has been arranged by the department of chemical engineering and chemical technology at the Imperial College of Science and Technology. The course provides a general training in the chemical, chemical engineering and metallurgical aspects of nuclear technology, interpreted in a wide sense, and is intended for graduates in chemical engineering, chemistry and metallurgy and other suitably qualified applicants. Satisfactory completion of the course leads to the award of the Diploma of Imperial College. The course fee is £64. Application for admission should be made by 1 June on a form obtainable from the Registrar, Imperial College, London, S.W.7.

**Radiochemistry.**—A short practical course on radiochemical apparatus and techniques will be held at the Loughborough College of Technology on 17-21 July. Lectures, on essential subjects such as principles and operation of counting equipment, methods of producing and handling radioisotopes, and health hazards, will be kept to a minimum; the major part of the time will be taken up with practical work. The fee for the course is £10, and that for accommodation, including all meals, is £7 10s. Application should be made to the Head of the Department of Applied Chemistry, Loughborough College of Technology, Loughborough, Leicestershire.

**Reactor Fuel Element Technology.**—A course of lectures designed to lay emphasis on the industrial problems of reactor fuel-element technology is being held at the department of chemical engineering and chemical technology, Imperial College of Science and Technology, on 4, 11 and 18 May. Scientists and technologists who are interested in the metallurgical aspects of nuclear power development, and who would like to attend this course of lectures, should apply to the Registrar of the College, London, S.W.7.

## MEETINGS AND CONFERENCES

**Analysis of Metals.**—A symposium on 'Recent Developments in the Analysis of Metals' will be held at Whitehaven College of Further Education on 4 May.

Topics will include both instrumental and non-instrumental methods. Further details may be obtained from the Head of the Chemistry Department, College of Further Education, Whitehaven, Cumberland.

**Biochemistry of Fats.**—A two-day symposium on 'Recent Advances in the Biochemistry of Fats' is being arranged by the Department of Applied Science, Wolverhampton and Staffordshire College of Technology, for 11 and 12 May. Full details may be obtained from the Department at Wulfruna Street, Wolverhampton.

**Chemical Institute of Canada.**—The next conference of the chemical engineering division of the C.I.C. will be held on 6-8 November at the Royal York Hotel, Toronto. Among the topics for discussion are the petrochemical industry, nuclear engineering, and chemical engineering at high temperatures and/or pressures. A special feature of the Conference will be the presentation of the R. S. Jane Memorial Lecture. Prospective speakers are asked to send titles of proposed papers and brief summaries to the chairman of the technical programme committee, R. W. Missen, Department of Chemical Engineering, University of Toronto, Toronto, Ontario.

**Institute of Metal Finishing.**—The Annual Conference of the Institute of Metal Finishing will be held at Llandudno on 2-6 May. The programme includes five technical sessions and the Seventh Hothersall Memorial Lecture, to be given by Dr A. Brenner on the evening of 4 May. Further details may be obtained from the Conference Secretary, 32 Great Ormond Street, London, W.C.1.

**Plastics Institute.**—A conference on education and training in the plastics industry will be held on 19-20 June at the Institution of Electrical Engineers.

The London Sections of the Plastics Institute and the Institution of the Rubber Industry are holding a conference on foamed rubber and plastics at the Institution of Electrical Engineers on 5 May. Registration forms for both these conferences may be obtained from the Secretary, The Plastics Institute, 6 Mandeville Place, London, W.1.

**Radiation Chemistry.**—Two lectures on 'Recent Advances in the Radiation Chemistry of Aqueous Systems' will be given by Professor Gabriel Stein, head of the department of physical chemistry, Hebrew University of Jerusalem, Israel, in the Department of Chemical Engineering and Chemical Technology, Imperial College, Prince Consort Road, London, S.W.7, at 4 p.m. on 3 and 10 May. The first lecture will be on basic processes in aqueous solutions and the second on some systems of biochemical interest.

**Society for Analytical Chemistry.**—The 87th Annual General Meeting of the Society was held on 3 March at Burlington House, with the President, Mr R. C. Chirnside, in the Chair. The following Officers were elected for the forthcoming year: President, Dr A. J. Amos; Past Presidents serving on the Council, Mr R. C. Chirnside, Dr J. H. Hamence, Dr D. W. Kent-Jones and Dr K. A. Williams; Vice-Presidents, Mr A. L. Bacharach, Dr J. R. Edisbury, Mr F. C. J. Poulton; Honorary Treasurer, Dr D. T. Lewis; Honorary Secretary, Dr R. E. Stuckey; Honorary Assistant Secretaries, Mr C. A. Johnson (Programmes Secretary) and Mr S. A. Price (see also p. 155).



Mr E. LeQ. Herbert, *President*, with Lord Fleck at the S.A.C. Anniversary Dinner

The Anniversary Dinner was held in the evening at the Fishmongers' Hall. Guests included The Lord Fleck, K.B.E., F.R.S., Mr E. LeQ. Herbert, *President*, Sir Harry Jephcott, *Past President*, Sir Charles Goodeve, O.B.E., F.R.S., and Dr J. H. Hamence.

**Society of Chemical Industry.**—The Society's Annual Meeting will be held in Oxford from 10 to 14 July. Lectures, visits and tours are being arranged and reservations of accommodation have been made in three colleges. The Annual Dinner will be held in the Great Hall of Keble College. Further details may be obtained from the General Secretary, Society of Chemical Industry, 14 Belgrave Square, London, S.W.1.

**Symposium on Inorganic Polymers.**—An International Symposium on Inorganic Polymers, sponsored by the Chemical Society, will be held at the University of Nottingham on 18-21 July, as previously announced (J., 1960, 410). Registration forms may be obtained from the General Secretary, The Chemical Society, Burlington House, London, W.1, and should be returned not later than 10 June.

## RECENT PUBLICATIONS

**Dechema Monograph.**—The Dechema Deutsche Gesellschaft für chemisches Apparatewesen has recently published a brochure giving information on the aims and tasks of the Dechema, and how it has achieved its objectives in the 35 years of its existence. The publication is trilingual—English, French and German—and is available free of charge from Dechema, Frankfurt am Main 7, Postfach 7746, Germany.

*Beiträge zur Entwicklung des chemischen Apparatewesens*, Volume XXXVIII of the Dechema Monographs, has just been published by Verlag Chemie GmbH, Weinheim/Bergstrasse, price DM 28 to the Society's members and DM 35 to non-members. The book (pp. 404) includes 16 papers presented to the Society's Annual Meeting, 1959, dealing with new and important advances achieved in various branches of chemical engineering. Five further papers, given at the Dechema Colloquia, discuss molecular amplifiers, galvanic fuel elements and the flotation of salts. Abstracts of individual papers in English and French are appended.

**Radiological Units and Measurements.**—The International Commission on Radiological Units and Measurements was established in 1925 by the first International Radiological Congress to define physical units in the field of radiology and their measurement. The 1959 report (*Report of the International Commission on Radiological Units and Measurements* (I.C.R.U.) 1959. Pp. x + 90. 65 cents) appears as U.S.A. National Bureau of Standards Handbook 78. In the previous report there is a short description of the working relationships between I.C.R.U. and other international bodies.

Part I defines the units of absorbed and exposure dose and states the conditions under which they can be realized for radiations of different types and energies. Brief mention is made of three quantities which are of importance in the measurement of dose, linear energy transfer (L.E.T.), mass stopping power and relative biological effectiveness (R.B.E.).

Part II examines critically the concept of absorbed and exposure dose for radiations of varying types and energies in clinical and biological application. Valuable information is given on dose measurement in soft tissue and bone, at the boundary between the two and in small cavities within the boundary. Attention is drawn to common errors and their magnitudes in clinical dosimetry and useful recommendations are made to achieve greater accuracy.

Part III deals with physical aspects of dosimetry and reports on international comparisons of standard free-air chambers for X- and  $\gamma$ -radiation in the range 0.5–3 MeV. The derivation of absorbed dose from measured ionization due to X-,  $\gamma$ -,  $\beta$ - and neutron-radiations is dealt with in some detail, and illustrative

calculations are made, including the estimation of dose due to mixed radiations. A useful feature of this part of the report is the linear energy transfer distributions due to various primary radiations in water. There are special sections dealing with dose estimation using chemical methods, solid-state devices, including scintillators, glasses and thermoluminescent materials. Brief reference is made to calorimetric and photographic measurements. The solutions used in chemical dosimetry are ferrous sulphate, which is oxidized, and ceric sulphate, which is reduced. The range of measurement is  $10^3$ – $10^6$  rad. More sensitive chemical dosimeters make use of the release of HCl from chlorinated hydrocarbons and cover the range  $10$ – $10^4$  rad. An application of particular interest is the use of gels for depth dose measurement. These gels contain dyes (e.g. methylene blue) which are decolorized by radiation.

Part IV is the report of Committee I and deals with radioactivity standards and their international comparison. For many radioactive isotopes there has been a satisfactory agreement between the national standardizing laboratories.

The I.C.R.U. report contains much valuable information for all workers in the radiation measurement field and many sections are of direct interest to hospital and health physicists. The various Committees are to be congratulated on the high proportion of information given in this report in the form of tables and diagrams, which is new since the issue of the previous I.C.R.U. Report (Handbook 62) in 1956.

A. QUINTON

**Soviet Technology Digest.**—In the first number of *Soviet Technology Digest* (December, 1960, annual subscription £10), a bulletin about technological developments in the Soviet Union and Eastern Europe which Pergamon Press intends to publish monthly, 45 pages are devoted to abstracts under the headings 'Design and Production,' 'Metallurgical Welding and Foundry Production,' and 'Instruments and Automation.' In addition there are 89 pages devoted to translations of titles of articles from various journals, either under the above classification or under the heading 'Additional Contents List.' There are eight pages of general information, one book review and information about five other books.

So far as chemists are concerned, this publication will interest only those working in the metallurgical or allied fields. If these workers are interested in information from Russia they are likely to be aware that full translations of many of the metallurgical papers referred to in this first number were available in the United Kingdom before the Digest appeared. Add to this the indifferent classification and the evidence of hasty compilation and one is tempted to conclude that in its present form this periodical is not likely to attract many readers.

N. BOOTH

## HORIZONS IN ANALYTICAL CHEMISTRY

On 3 March Mr R. C. Chirnside delivered his Presidential Address on 'The Enlargement of Horizons in Analytical Chemistry' to the Society for Analytical Chemistry.

He said that it was just 50 years since the then President, Mr E. W. Voelcker, in speaking of the incorporation of the Society to embrace all branches of the analytical profession, had referred to 'the enlargement of our horizons.' In the golden age of analysis in the last century the composition of much that went to make up the material world had been charted. Later the emphasis had shifted to the control of materials by analysis, an objective no longer so unambiguously scientific, and there had been some lowering of the status of analysis and of the analyst.

In seeking to provide a professional analytical service in the environment of industrial research, he had found it necessary to develop a new and a wider conception of what constituted analytical chemistry. The analyst had to enlarge his knowledge so as to be able to comprehend his customers' problems. Without this he might fail to satisfy those who sought his aid. Some of the major advances in analytical techniques and tools in the last 20 years had come, not from analysts, but from those who wanted information outside the conventions of the analyst. There were many today—chemists, physicists, biochemists—vitally engaged in what were truly analytical problems, who would not admit to the practice of analysis and would reject the label analyst.

The distinction between testing and analysis, sometimes obscured in the past, often became clearer with the development of automatic equipment, some of which gave conventional information in a sensational short time. Some other instrumental techniques provided entirely new kinds of information, all of which were vital to the study and understanding of materials in the newer applications for which they were required.

Some of the chemistry was going out of analytical chemistry, and this raised problems, not only for the industrial analyst, but also for the analytical interests of the universities and the colleges of technology. Micro-chemistry, too, as conventionally defined, would have to take note of the newer techniques of electron diffraction and the electron micro-probe, for example. By means of these it was now possible to make a point-to-point analysis over minute areas of specimen, often non-destructively. Such information might prove to be of inestimable value, greater by far than the average figures obtained on relatively large samples. This was already true of solid-state devices such as the semi-conductors. It must surely be applicable to both the metallurgical and the biochemical fields of work.

The next 30 years, it could be confidently predicted, would see some radical changes in 'analytical chemistry.' Mr Chirnside thought the Society would have 'to

enlarge its horizons' to an extent never dreamt of by Voelcker in 1912.

## TECHNICIANS IN THE CHEMICAL INDUSTRY

A sample survey of the employment of technicians in the chemical and engineering industries was carried out in 1960 by the Ministry of Labour. The object of the survey was to gain information on the proportion of technicians to other workers, the proportions engaged on different kinds of work, their qualifications and the present and future demand for their services. The results of the survey are analysed in an article in the *Ministry of Labour Gazette*, December, 1960.

The inquiry was limited to 400 private firms in the chemical and engineering industries, of which three-quarters employed over 1,000 workers. In the chemical and allied industries under survey, 5 per cent of the employees were qualified scientists and engineers, 7.9 per cent technicians, 16.6 per cent managerial, administrative and clerical and 70.5 per cent other employees. The proportion of women technicians was 10.4 per cent of the total number of technicians employed in the chemical industry. This is a far higher proportion than in the other groups surveyed—4.6 overall.

In the chemical and allied industries the proportion of technicians employed to each qualified scientist was 1.6:1. This is substantially lower than in any other group—the average being 4.2:1—and the inference drawn is that qualified scientists require a smaller proportion of technicians than do qualified engineers. In other industry groups the ratio varied from 4:1 in electrical engineering to 7.6:1 in motor vehicles and aircraft. The figures may, of course, simply reflect the supply of qualified men and technicians available and not the relative numbers required; this may mean that in certain industries qualified scientists are being used for technicians' work.

The results of the survey provide an analysis of technicians by industry group and type of work. In the chemical and allied industries 32.6 per cent were employed on research and development work, 15.4 per cent in design and drawing offices, 24.5 per cent on testing, inspection and analysis and the remainder on other aspects of production. Of the female technicians in the chemical industry, 34 per cent were employed in research and development laboratories and 54 per cent on testing, inspection and analysis.

The survey also shows that 17.9 per cent of the technicians in the chemical and allied industries are holders of a H.N.C. or H.N.D., 12.4 per cent had an O.N.C., 2.5 per cent a City and Guilds of London Institute qualification, 12 per cent G.C.E. 'A' level, 18 per cent had some other examination qualification and 37.2 per cent had no qualification. Of the industries under survey the chemical group had the highest proportion of 'qualified' technicians (62.8 per cent).

**Pure Food Centenary, 1960.**—The Executive Committee responsible for organizing the recent celebration of the first comprehensive Pure Food Act in 1860 has announced that the sum of £3,000 has been donated to the Science Museum for the purpose of providing a permanent food exhibit in a gallery now being redesigned (*see* also p. 126).

**Scientific and Industrial Research in Pakistan.**—The Twelfth Session of the Governing Body of the Pakistan Council of Scientific and Industrial Research was held in Karachi on 26 February. Opening the conference, the Minister for Industries, Mr A. K. Khan, said that industrial research had acquired a tremendous significance in modern industrial development. It had opened new vistas in utilization of natural resources. The Government of Pakistan, recognizing its role in building up a prosperous country, had appointed a Scientific Commission, whose recommendations had been accepted. The Minister appointed a Committee to draw up a comprehensive programme, which the Council will carry out in the light of the Scientific Commission's Report. He said that the Council should consider bringing out a journal in English, Urdu and Bengali to popularize scientific and industrial research in the country on a wider scale.

**News from I.C.I.**—To provide better facilities for the rapid manufacture of tonnage batches of its many development products, Imperial Chemical Industries Limited's Heavy Organic Chemicals Division is erecting at Billingham a general-purpose pilot plant. This is due for completion in late 1962. Equipment will be provided for carrying out such reactions as alkylation, amination and condensation over a range of temperatures and pressures, with auxiliary equipment to treat the reaction products by unit operations such as washing, filtration, crystallization, drying and distillation. Products on the development programme of the Division which are already available in trial quantities include propylene derivatives, organic acids, alkylated phenols, alcohols and antioxidants.

I.C.I. is erecting a new polyvinyl chloride plant at their Hillhouse Works near Blackpool. This will raise their manufacturing capacity of PVC from the present figure of 70–80,000 tons a year to 115,000 tons a year by the beginning of 1963.

The Company will begin manufacturing operations on a substantial scale within the European Common Market, and to that end negotiations for acquiring a site of 300 acres near Rotterdam are well advanced. The Company intends to build a complex of chemical plants manufacturing petroleum chemicals, including plastics and related products, on this site. Construction is expected to begin early next year.

The new I.C.I. plant for manufacturing 'Melinex' polyester film was officially opened at Dumfries on 2

March. The plant has an annual production capacity of 2,000 tons or more (*see* photograph).



The General Chemicals Division, centred on Merseyside, is to build new research laboratories at Runcorn Heath. Small-scale laboratory research will be concentrated in the new buildings.

Within four months of the opening of the new 11,000-ton polypropylene plant at Wilton, it has been decided to build extensions so as to double the output.

## CORRESPONDENCE

### CHEMICAL BOND APPROACH

SIR,—We heartily welcome and endorse the article by Mr E. J. Rothery ('Suggested Changes in the Chemistry Syllabus,' *J.*, 2) describing the Chemical Bond Approach (C.B.A.) for the presentation of beginner's chemistry, the more so since we ourselves are putting this scheme to experimental test at the Middlesex Hospital Medical School. So far the students' response has been very encouraging.

Mr Rothery's description of C.B.A. being 'tried by several teachers in American high schools' is somewhat misleading, for very extensive evaluation trials are in operation all over the U.S.A., and plans are in hand for introducing C.B.A. to the newer nations of Africa. The financial support received from the National Science Foundation is beyond the most optimistic hopes of British educationalists. The second revised edition of the C.B.A. Teaching Volume I, covering the first half-year, has just been received by us.

The problem of teaching elementary chemistry in a London medical school is aggravated by the widely varying backgrounds of the students on entry, from those with 'no science' to those with 'A' level chemistry.

The interest of the latter must be maintained while bringing the novices to First M.B. level in nine months. It must be remembered that these students are also studying biology and physics to the same standard. However, in reorientating our methods of teaching we have an advantage over schools and most technical colleges in that we have internal examinations and that the University of London is encouraging new teaching programmes.

Briefly, our C.B.A. presentation is along the lines described by Mr Rothery, but directed toward the biochemistry course for Second M.B.; therefore the structure of metals and the chemistry of non-aqueous media receive only the briefest treatment—the 'seed catalogue' inorganic chemistry is eliminated by the C.B.A. in any case. On two points we would disagree with Mr Rothery's interpretation of C.B.A., both points having a special place in biochemical systems. Firstly, the remark that the concept of *equivalent* becomes superfluous cannot be supported. Using the electron-transfer description of oxidation-reduction and the Brønsted-Lowry description of acids, the equivalent becomes the amount of material in atomic weight units which is involved in the transfer of one electron or one proton, and as such is of great value in chemical calculations, volumetric analysis and the description of the complex ionic mixtures found in the body fluids. Secondly, writing of oxidation-reduction, Mr Rothery refers to the obsolete concept of hydrogen removal and oxygen gain, but does not make clear how he would treat oxidations of the type  $\text{CH}_3\text{-CHO} \rightarrow \text{CH}_3\text{-COOH}$  in terms of electron transfer. We therefore still use both concepts in order to deal with oxidations of the above type as well as the  $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+}$  variety, both kinds being involved together in metabolic oxidation.

We are most anxious to hear from other British departments who are trying out the C.B.A., or who would wish to learn more about it. If sufficient experience can be shared, the teaching of chemistry in Britain could benefit as much as it is doing in America.

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D. G. O'SULLIVAN  
JOHN B. JEPSON

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Middlesex Hospital Medical School,  
London, W.1

#### BRITISH STANDARD PIPETTES

SIR,—I am writing as the Institute's Representative on the British Standards Institution Technical and Sub-committees for Volumetric Glassware.

As a result of the recently published Revision B.S. 1583: 1961, one-mark pipettes made to the British Standard will in future have no drainage time. I quote

from the Standard: 'He (the user) should merely remove the pipette from contact with the vessel, as soon as he is satisfied that the meniscus has come to rest, without undue haste or delay.' A nominal three seconds is suggested.

D. J. WEBLEY

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#### SMALL-SCALE EXPERIMENTAL CHEMISTRY

SIR,—I am writing with reference to a review by H. Holness on 'Small Scale Experimental Chemistry,' published in your January number (J., 20). Mr Holness states categorically that concentrated hydrochloric acid does not separate copper from cadmium. Copper sulphide is not appreciably soluble in concentrated hydrochloric acid and this method of separation is, in fact, quite satisfactory for the purpose of identification. It is also, in the hands of inexperienced students, considerably safer than the traditional cyanide separation. Perhaps Mr Holness uses hydrochloric acid containing free chlorine. This would explain his comment.

With regard to the contamination which is allegedly introduced by the use of caustic soda and hydrogen peroxide to separate the copper sub-group from the arsenic sub-group, he states this must cause some sulphate formation and consequently contaminate the soluble portion. Might I point out that this table is intended for the separation of cations and not anions?

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Leatherhead,  
Surrey

Mr Holness writes: 'I can appreciate the author's desire to avoid the use of cyanide in a school laboratory, and I would not dispute that the use of concentrated hydrochloric acid would allow the *identification* of cadmium or copper in a scheme of analysis used for 'A' level purposes with its restricted syllabus. It is the author's intention to use the scheme for the *separation* of two or more cations in the copper sub-group that is open to criticism, since the use of concentrated hydrochloric acid does not give *clean* separations of copper from cadmium.'

Regarding the use of caustic soda and hydrogen peroxide to 'part' the arsenic sub-group from the copper sub-group, any insoluble metallic sulphide that is oxidized to a soluble metallic sulphate must contribute also cations to the soluble portion and thereby contaminate it.'

## OBITUARY

**Ernest Robert Andrews.** *B.* 27.8.1876. *Ed.* became an assistant to W. Macnab in 1895 and two years later was appointed chemist to Pegamoid Ltd. In 1899 he joined the London County Council as chemist-in-chief, a post he held until his retirement. He delivered the Eighteenth Streatham Memorial Lecture entitled 'Chemistry in Local Government Administration' in 1936. (*A.* 1897, *F.* 1901). *D.* 28.12.60.

**Bernard James Balf.** *B.* 29.4.12. *Ed.* Clapham College; Battersea Polytechnic, 1928-32. B.Sc. He became a research chemist at the British Leather Manufacturers Research Association in 1933, and the following year joined James Watkins & Sons, Portsmouth, as a works chemist. He left in 1935 to take a temporary post as an assistant chemist in the Department of the W.D. Chemist. A year later he was appointed development chemist at Nobel Chemical Finishes Ltd (now Imperial Chemical Industries Ltd, Paints Division), where he remained until the time of his death. (*A.* 1933, *F.* 1944). *D.* 26.12.60.

**Harry Barnes.** *B.* 23.10.1895. *Ed.* University of Liverpool, 1914-15, 1919-23. B.Sc., Ph.D. After serving with H.M. Forces, 1915-19, he returned to his studies. He became a works chemist at the Co-operative Wholesale Society's Soap Works at Irlam in 1923, and three years later took a post as a research chemist at the Chemical Research Laboratory, Teddington. He was appointed a research chemist at Boots Pure Drug Co. Ltd in 1939, and remained there until his retirement in 1957. (*A.* 1922, *F.* 1948). *D.* 12.12.60.

**Edward John Bond.** *B.* 7.1.01. *Ed.* Loughton School; West Ham Municipal College, 1920-25. B.Sc. He began his career in 1917 as an apprentice in engineering at the Gnome & Le Rhone Engine Co., but forsook the industry to become a chemist at Madderton & Co., Loughton, in 1921. Four years later he joined Lewis Berger & Sons Ltd as chemist in charge of paint and varnish development. He left in 1933 to take a post as chief chemist to Goodlass, Wall & Co. Ltd. He remained with the firm until the time of his death, when he was managing director. Despite the heavy calls made upon him by his work, he found time to indulge in his favourite hobby of gardening, personally maintaining a beautiful garden at his home and acting as a member of the Ness Gardens Management Committee, part of the Botanical Department of the University of Liverpool. (*A.* 1926, *F.* 1939). *D.* 22.12.60.

**Alfred Campion.** *B.* 3.8.1874. *Ed.* Finsbury Technical College, London, 1890-92. He commenced his career in 1893 as a teacher. In 1896 he became chief chemist and metallurgist to the Steel Co. of Scotland Ltd and remained there until 1901, when he was engaged as principal assistant chemist and metallurgist to the Indian Office. In 1904 he set up a private practice as a consulting chemist and metallurgist, but discontinued it in 1908 on his appointment as Professor of Metallurgy at the Royal Technical College, Glasgow. He relinquished the Chair in 1918 to become metallurgist and foundry consultant to the Foundry Technical Institute, Falkirk. When this closed in 1922 he joined Cameron & Robertson Ltd as technical and research manager. In 1924 he again set up a private practice and in 1933 became metallurgical and services engineer consultant to the International Mechanite Metal Co. Ltd; in this capacity he visited foundries all over the country. He retired in 1954, but continued to give advice when required. 'His quiet, charming personality will long be missed amongst many foundrymen.' (*A.* 1898, *F.* 1901). *D.* 9.1.61.

**Dick Carter.** *B.* 30.4.01. *Ed.* Huddersfield Technical College; University of Leeds, 1918-22. M.Sc. He became a textile chemist at the British Dyestuffs Corporation in 1923, and three years later head dyer and chemist at John Shaw & Sons. In 1927 he joined Imperial Chemical Industries Ltd, Dyestuffs Division, later becoming chief colourist. He was appointed director (research and development) to Wolsey Ltd in 1944. The following year he became managing director of Strachan & Co. Ltd, and was appointed chairman in 1946. He was also appointed a member of the board of the parent company, Winterbotham, Strachan & Playne Ltd. (*F.* 1944). *D.* 3.1.61.

**William Clayton.** *B.* 17.8.1891. *Ed.* Oulton Secondary School, Liverpool; University of Liverpool, 1910-15. D.Sc. He began his career as a works chemist at Burroughs, Wellcome & Co. in 1915. The following year he took a post as research chemist at the English Margarine Works Ltd and thereafter became successively research physical chemist, High Speed Alloys Ltd, 1916; chief chemist, Calders Margarine Co. Ltd, 1918; deputy chief chemist, Salt Union Ltd, 1920; chief chemist, Crosse & Blackwell Ltd, 1927; and head of technical development department, the Metal Box Co. Ltd, 1938. He was seconded to the Ministry of Food in 1940, and after the termination of his duties there joined Scribbans-Kemp Ltd as technical director in 1946. He retired in 1955, but continued as scientific adviser for the remainder of his life. He was the author of a number of papers and of *Margarine* (1920); *Colloid Aspects of Food Chemistry and Technology* (1932); and *Theory of Emulsions and their Technical Treatment* (1923). (*A.* 1918, *F.* 1922; Council 1927-30). *D.* 1.1.61.

**Harold Edward John Cory.** *B.* 19.7.1889. *Ed.* School of Technology, Manchester, 1905-08. M.Sc.Tech. He became works chemist and process manager at Chance & Hunt Ltd, Oldbury, in 1910. Thereafter he was appointed successively works manager, Midland Acid Co., 1915; chemist in charge of acid departments, British Dyes Ltd, 1916; chemical engineer, Rowe Bros & Co. Ltd, 1917; works manager, Spencer, Chapman & Messel, 1918; works manager, Elton Levy & Co., 1919; departmental manager, Jenson, Lawson & Co., 1920; technical sales manager, Chance & Hunt Ltd, 1927; and sole managing director, Egglecliff Chemical Co. Ltd, 1938, resigning in 1940. The following year he set up the Eagle Chemical Works, of which he remained in control for the rest of his life. (*A.* 1918, *F.* 1928). *D.* 11.11.60.

**Cecil John Turrell Cronshaw.** *B.* 13.6.1889. *Ed.* Bury Grammar School; University of Manchester. B.Sc. (Manc.), Hon. D.Sc. (Leeds). In 1915 he joined Levinstein Ltd as a research chemist, becoming chemist in charge, oleum plant, in 1916, and manager, Ellesmere Port works, in 1917. After the 1918 Armistice, he became chemical controller of the Rhineland Area factories in Germany for a year. He returned to England in 1919 as assistant to Dr H. Levinstein, managing director of the British Dyestuffs Corporation, which had been formed by the fusion of Levinstein Ltd and British Dyes Ltd. For three years he was works manager of their Blackley factory, where he was involved in the manufacture of some of the first rubber antioxidants and accelerators to be made in Britain on a commercial scale. In 1924 he became technical manager of the British Dyestuffs Corporation and when the Corporation became a full member of Imperial Chemical Industries Ltd he was first technical director, then managing director and finally, in 1939, chairman of the Dyestuffs Group, now known as the Dyestuffs Division. In 1943 he became a director of the main board of the company, and served in various posts on that board until his retirement in 1952. He delivered the fifth Dalton Lecture in 1948. 'Warm-hearted and generous in his encouragement of young chemists, he had a rapier-like wit and a mind of extraordinary quickness. Everything he did he tackled with great zest and single-mindedness, whether it was business or bee-keeping or sailing a boat. Whenever leisure permitted it he might be seen at the County Cricket Ground, or attending the Halle Concerts.' (*F.* 1928; Council 1936-39, 1946-48). *D.* 5.1.61.

**Charles Samuel Garland.** *B.* 23.6.1887. *Ed.* Wilson's Grammar School; Royal College of Science, London, 1905-09. B.Sc. Until 1912 he continued as a demonstrator at the College, where he made a special study of the rare earths. He then became chief chemist, works manager and subsequently a director of the Volker Lighting Corporation. In 1916 he became a director of Thorium Ltd and established the first British factory for extracting thorium, cerium, didymium and other rare earths from monazite sand. In 1920 Nobel Industries combined the principal manufacturers of thorium and cerium salts, etc., and he became managing director of the 'lighting trades' group, from which he resigned on being elected M.P. for South Islington in 1922. In 1923 he formed the Stream-Line Filter Co. Ltd, of which he was chairman and managing director until 1956 when the company

was acquired by outside interests. During 1940-45 the Stream-Line group of companies performed great services—to the RAF in the filtration of aviation spirit and to the forces in the Middle and Far East in water purification. He had earlier built at Stourport a ceramics factory whose products were essential for radar and h.f. work during the war. He served on several government committees, including the National Production Advisory Council on Industry from 1952; the Clean Air Council; and the Central Transport Consultative Committee. One of the founders of the Institution of Chemical Engineers, he was its first Hon. Registrar and its President in 1941-43. Awarded the Osborne Reynolds Medal, 1940.

From 1923 he represented the Crown on the governing body of Imperial College and from 1924 was a governor of the City and Guilds College. He was President of the British Association of Chemists in 1925-26 and of the National Union of Manufacturers, 1956-58. A prominent mason, he was a founder of the Radium Lodge, Imperial College Lodge, Arts and Sciences Lodge and the Old Wilsonians Lodge. He did not relax easily, but found much pleasure in horticulture and travel. On the rare occasions when he permitted himself a holiday, he enjoyed the simple life of camping and caravanning. (A. 1909, F. 1919). D. 4.12.60.

**Philip Morley Griffiths.** B. 15.10.01. Ed. Gowerton County School; University College of Wales, Aberystwyth. B.Sc. His first appointment was as assistant chemist at the National Oil Refineries Ltd, where he later became chemist in charge of laboratories, 1924, assistant shift superintendent, 1925, and personal assistant to process superintendent, 1926. He left in 1927 to take a post as acting chief chemist to the Mexican Eagle Oil Co., Minatitlan, Mexico, and in 1934 was promoted to refinery superintendent at Tampico. Two years later he was loaned as manager to Arend Petroleum Maatschappij, Aruba, Netherlands West Indies. In 1946 he returned to this country to take a post as technological department manager, Shell Refining & Marketing Co. Ltd. Later he joined the Shell Chemical Co. Ltd as manager, manufacturing operations department. (A. 1923, F. 1937). D. 21.11.60.

**Erik Semon Henley.** B. 18.2.11. Ed. Rotherham Grammar School; University of Bristol, 1929-32. B.Sc. He became an elementary school teacher under the Rotherham Education Committee in 1933. In 1938 he was appointed science teacher at Spurley Hey Central School, Rotherham. He became a shift chemist in a Royal Ordnance Factory in 1942, and after the close of the war returned to his former post, later becoming senior science master. Some years later he took a similar post at Oakwood Technical High School. At the time of his death he was head of the Science Department. (A. 1945). D. 10.11.60.

**Albert Arthur Henly.** B. 21.1.22. Ed. Cardiff Technical College, 1937-44. B.Sc., Ph.D. (Lond.). He became a junior laboratory assistant at the Welsh National School of Medicine in 1937. He left in 1942 to take a post as laboratory technician at Whitchurch Emergency Hospital. Three years later he took a post as junior biochemist at the Medical Unit, London Hospital, and in 1949 became a Roche Fellow in Biochemistry, Empire Rheumatism Council, at the Hospital of St John and St Elizabeth, London. In 1953 he was appointed biochemist at Little Bromwich Hospital, Birmingham, where he remained until the time of his death, when he was principal biochemist. (A. 1944, F. 1953). D. 15.1.61.

**Robert Leonard Jenks.** B. 8.3.1871. Ed. Manor House School, Clapham; City of London School; City and Guilds of London Institute, 1889-92. He became honorary demonstrator and private assistant to the late Professor H. E. Armstrong at the City and Guilds of London Central Institute in 1892. Two years later he joined the Imperial Institute as chief assistant chemist in the Scientific Department, and remained there until 1900, when he set up in practice as an analytical and consulting chemist. In 1904 he closed the practice and went to Kasauli, India, as senior assistant to Major (later Sir Charles) Bedford on the native spirituous liquors investigation. At the close of the investigation he was sent to Calcutta and appointed as the first Chemical Examiner, Customs and Excise, in 1911, a post which he retained until his retirement in 1928. His responsibilities were heavy and varied. His Indian staff found him always accessible, sympathetic

and helpful. During his long retirement, he regularly corresponded with members of his old staff. When he could relax, his pleasures were golf, bridge and fishing. (A. 1899, F. 1902). D. 23.10.60.

## THE REGISTER

### NEW FELLOWS

(OH) BANERJEE, Bhupati Kumar, D.Sc., D.PHIL. (CALC.)  
 (R) COOKSON, Prof. Richard Clive, M.A., PH.D. (CANTAB.)  
 (Q) DAVISON, Brian Kay, B.Sc., PH.D. (DURH.)  
 (H) GREENWOOD, Norman Neill, M.Sc. (MELB.), PH.D. (CANTAB.),  
 A.R.A.C.I.  
 (P) LEICESTER, Jack, M.I.CHEM.E., A.I.MAR.E.

### ASSOCIATES ELECTED TO THE FELLOWSHIP

ADAIR, David, M.Sc. (LIV.)  
 (P) ALLEN, John  
 (C) ARGYLE, Alfred  
 (P) BOND, Raymond Leslie, B.Sc. (LOND.), M.INST.F.  
 (O) BOULTON, Derek Malcolm William, B.Sc. (LIV.)  
 (C) COLLINS, Henry Hubert, A.C.T. (BIRM.)  
 (P) COWLEY, Eric, B.Sc. (DURH.)  
 (G) COX, Stewart Francis, B.Sc. (SYD.), PH.D. (LOND.), F.R.A.C.I.  
 (O) DAVIES, Noel Hugh, B.Sc., PH.D. (WALES)  
 (C) ELLIS, William  
 (OG) GUHA, Subramanyam Rama Das, M.A., M.Sc. (MADR.),  
 PH.D. (BOM.)  
 (P) HODGSON, Alan Algarth, B.Sc. (LOND.)  
 (S) INSKIP, George, B.Sc. (DURH.)  
 (P) KEATTCH, Cyril Jack  
 (P) LAWLER, James Joseph, B.Sc. (N.U.I.)  
 (P) MAY, Charles Gerard, M.Sc., PH.D. (MANC.)  
 (C) MORE, John Walter, B.Sc. (LEEDS)  
 (C) MYTUM, Ernest, M.A. (CANTAB.), A.R.P.S.  
 (R) NASH, Geoffrey James Chetwode  
 (C) RADFORD, Charles, B.Sc. (NOTT.), A.I.CERAM.  
 (OE) RAMAMURTI, Prof. Krishnamurti, B.Sc. (MADR.), M.A.,  
 B.Sc. (ANNAM.), M.Sc. (COL.), M.Sc. (MANC.), M.I.BIOL.  
 (P) ROSE, Charles Francis Matthew  
 (P) SHOOP, Stanley, B.Sc. (LOND.), A.M.INST.F.  
 (Y) STRAIN, Robert Noel Claude, M.Sc. (BELF.), PH.D. (R'DG)  
 (X) TAYLOR, Alan Scott, B.Sc. (DURH.)  
 (D) TAYLOR, David John, B.Sc. (LOND.)  
 (T) TREVETT, Michael Edwin, M.A. (CANTAB.), PH.D. (LOND.)  
 (R) WARDROP, Arthur William Hamilton, G.M.  
 (Q) WELLS, Colin Durant, B.Sc. (LOND.)  
 (S) WIBBERLEY, Denman George, B.Sc., PH.D. (LOND.)

### NEW ASSOCIATES

(OE) APPA RAO, Ummrithala, M.Sc. (AND.)  
 (G) BARRETT, Gordon Edward, B.Sc. (LOND.), PH.D. (DURH.)  
 (O) BEG, Khalid, M.Sc. (PANJ.)  
 (OG) BHATNAGAR, Rajendra Kishore, M.Sc. (DELHI)  
 (X) BUNFORD, Edward, B.Sc. (WALES)  
 (Y) CROALL, Ian Francis, M.Sc. (MANC.)  
 (P) DAVIES, Henry Meurig, B.Sc. (WALES)  
 (O) DUNSTAN, Ivan, B.Sc., PH.D. (BRIST.)  
 (P) FILSON, Arthur Cole, B.Sc. (N.S.W.U.T.), PH.D. (LEEDS),  
 A.S.T.C.  
 (B) GILMOUR, Alexander, M.Sc., PH.D. (BELF.)  
 (OE) GUHA, Bimalananda, B.Sc. (CALC.)  
 (L) HARRIS, Derek Neville, B.Sc. (MANC.)  
 (C) JOHNSTONE, James Harvey, B.Sc. (ST AND.)  
 (P) KETT, Doris Mary, B.Sc. (LOND.)  
 (P) KOUMIDES, Orestis, DIP.CHEM.  
 (J) KRUEGER, Peter, M.Sc. (MANIT.), D.PHIL. (OXON.)  
 (C) LIVINGSTON, Daniel, A.R.C.S.T.  
 (MAY, Herbert, M.Sc. (LOND.), A.P.I.  
 (P) MITCHELL, James Vernon, F.P.S.  
 (P) MOORE, Alan Walter, M.Sc., PH.D. (NEBRASKA)  
 (P) MUNDAY, Ronald Sidney, B.Sc. (EXE.)  
 (P) PANTALL, David Brian, B.Sc. (NOTT.), M.Sc. (LOND.), DIP.  
 CHEM.ENG.

(S) Pieczka-Parker, Joseph Pawel, A.T.I.  
 (P) Poole, John Brian, B.A.(OXON.)  
 (J) Purves, David, B.Sc., PH.D.(EDIN.)  
 (R) Rafiq, Mohammad, B.Sc., B.PHARM.(PANJ.), PH.D.(LOND.)  
 (OD) Ramam, Ramakrishnaiyer, M.Sc.(KERALA)  
 (H) Reynolds, Kenneth George, B.Sc.(LOND.)  
 (OH) Roychaudhuri, Dilip Kumar, M.Sc.(CALG.), PH.D.(IOWA)  
 (P) Singleton, Dennis Oswald, B.Sc.(LOND.)  
 (WW) Snaden, Thomas Lewis, B.Sc.(EDIN.)  
 (Q) Stoker, Gerald Basil, B.Sc.(MANC.)  
 (P) Sutcliffe, Malcolm Leslie, B.Sc.(MANC.)  
 (P) Thomas, Graham Howard, M.Sc.(WALES)  
 (B) Thow, David Henry, B.Sc., PH.D.(EDIN.)  
 (N) Tordoff, Maurice, B.Sc.(ST AND.), PH.D.(LEEDS)  
 (P) Van Maarseveen, Gerard, B.Sc.(NATAL)  
 (P) Wale, Clifford Leslie, B.A.(OXON.)  
 (P) Westbrook, John Broughton, B.Sc.TECH.(MANC.)  
 (P) Williams, Thomas Henry, B.Sc.(LOND.), M.Sc.(YALE)

#### GRADUATE MEMBERS ELECTED TO THE ASSOCIATESHIP

(G) Appleton, Norman Arthur  
 (P) Barton, John Alfred  
 (J) Catto, George Alexander, A.H.-W.C.  
 (P) Collins, Alfred Charles, B.Sc.(LIV.)  
 (P) Cox, Alan Michael  
 (P) Crossley, John, B.Sc.(LOND.)  
 (O) Davies, John Rendal  
 (P) Dickinson, Ivor William  
 (C) Dryburgh, Peter McAllister, B.Sc.(ST AND.)  
 (P) Forbes, Alan David, B.Sc.(ABERD.)  
 (C) Gibbins, Lawrence Norman, B.Sc.(BIRM.)  
 (WW) Hay, James Neilson, B.Sc., PH.D.(GLAS.)  
 (C) Holden, Robert Stanley, M.Sc.(MANC.)  
 (H) Howard, Frederick John, B.Sc.(LOND.)  
 (E) James, Edward Arnold, B.Sc.(WALES)  
 (P) Lewis, David John  
 (O) Oben, Thomas Njang Ako, B.Sc.(LOND.)  
 (O) Owens, Dennis Raymond  
 (P) Player, David Hugh  
 (P) Preuveeneers, Michael Whitmore, B.Sc.(LOND.), A.R.C.S.  
 (P) Smith, William, B.Sc.(LOND.)  
 (O) Stannard, Brendan, M.Sc.TECH.(MANC.), A.M.C.T.  
 (O) Wass, Malcolm John  
 (S) Weir, Alan Pyle  
 (U) Whinfrey, Peter  
 (O) Woods, Harry, B.Sc.(EXE.)

#### NEW GRADUATE MEMBERS

(G) Barker, Michael Raymond  
 (P) Bush, Derek Raymond  
 (P) Chambers, Mary Evelyn Rainer, DIP.TECH.  
 (Y) Chittenden, Gordon James Frederick  
 (P) Constantiades, Eriticos, B.Sc.(LOND.)  
 (C) Crosby, Thomas Spain, B.Sc.(MANC.)  
 (P) Cross, John Thomas Daniel  
 (C) Cutler, Eric, B.Sc.(SHEFF.)  
 (P) Drake, John Francis, B.Sc.(NOTT.)  
 (SS) Earnshaw, George Wyndham  
 (C) Fare, Godfrey, B.Sc.(BIRM.)  
 (C) Field, Robert Harry, DIP.TECH.  
 (SS) Fisher, Keith  
 (P) Franco, Carol Helena, B.Sc.(BRIST.)  
 (Q) Glen, Alan Ernest  
 (P) Gould, Raymond Alfred  
 (O) Gray, Stephen Percy  
 (P) Hall, William Anthony, B.Sc.(LOND.)  
 (Q) Harrison, Albert Keith  
 (P) Harwood, Sheila Mary, B.Sc.(S'TON)  
 (O) Holding, Stanley Thomas  
 (O) Johansen, William Henry  
 (O) Kershaw, Bernard John  
 (P) Kinnibrugh, David Robin, B.Sc.(LOND.)  
 (N) Miles, Roy, B.Sc.(LEEDS)  
 (P) Moore, Alan Thomas  
 (S) Morland, John Beadling  
 (X) Nixon, Colin

(E) Preston, Virginia, B.Sc.(WALES)  
 (S) Quash, Gerard Anthony, B.Sc.(N.U.I.)  
 (U) Ridgley, Daniel  
 (O) Sanderson, Harold Alec, B.Sc.(LIV.), A.R.T.C.S.  
 (C) Sewell, Peter Aloysius  
 (P) Sherwell, Janet Mary, B.Sc.(BIRM.)  
 (O) Strike, Anthony Herbert  
 (P) Sudworth, James Lowe  
 (L) Symes, Ann Rosemary, B.Sc.(LOND.)  
 (Q) Thackray, Arnold Wilfred, B.Sc.(BRIST.)  
 (Y) Turner, Derick  
 (Y) Voice, Eric Handley

#### DEATHS

(W) Bury, Frank Ward, B.E.M., M.Sc.(MANC.). Died 19 February, 1961, aged 72. A. 1923, F. 1933.  
 (S) Dodd, Robert Edward, M.A., B.Sc.(OXON.). Died 25 February, 1961, aged 35. A. 1947, F. 1958.  
 (O) Fletcher, Alfred Edward. Died 27 January, 1961, aged 59. A. 1924, F. 1931.  
 (W) Graymore, John George, M.Sc., PH.D.(LOND.). Died 23 February, 1961, aged 62. A. 1927, F. 1940.  
 (C) Jacobus, Arthur, DR.PHIL.(BERLIN). Died 27 February, 1961, aged 63. A. 1947, F. 1957.  
 (P) Murray, Henry, B.Sc.(N.U.I.). Died 15 February, 1961, aged 55. A. 1927, F. 1958.  
 (Q) Naylor, Henry. Died 18 February, 1961, aged 69. A. 1922, F. 1925.  
 (Q) Norris, William Henry Hobbs, M.A.(CANTAB.), B.Sc.(LOND.). Died 1959, aged 75. A. 1911, F. 1917.  
 (L) Smout, Sir Arthur John Griffiths, LL.D.(WALES). Died 21 February, 1961, aged 72. A. 1918, F. 1945.  
 (L) Strausz, Hugo Johann, M.A., DR.PHIL.(HALLE). Died 10 February, 1961, aged 74. F. 1948.

#### Associates

(D) Tabor, Howard James, M.B.E. Died 26 February, 1961, aged 71. A. 1943.  
 (D) Weir, Arthur Rose, B.Sc.(LOND.), R.NAT.DR.(PRAGUE). Died 4 March, 1961, aged 55. A. 1930.

#### LOCAL SECTIONS DIARY

Sections are glad to welcome members of other Sections to their meetings and social functions, except when numbers are restricted, as for works visits. Those wishing to attend meetings outside their own area are advised to write to the Hon. Secretary of the Section concerned, as the Institute cannot accept responsibility for any alterations or cancellations. All times are p.m. except where otherwise stated. For key to Local Sections, see J., 78.

(O) Birkenhead. 27 April, 7.30. Some Aspects of Biosynthesis. Prof. A. J. Birch. Technical College  
 (E) Cardiff. 28 April. 7. Modern Legislation in Relation to Food Additives. C. A. Adams. University College. Joint, S.A.C., S.C.I. (S. Wales) and S.C.I. (Food Group)  
 — 26 May. Annual General Meeting. Royal Hotel  
 (F) Cork. 21 April. The Chemist and the Internal Combustion Engine. W. S. Sellers. University College. Joint, C.S., S.C.I. and Institiud Ceimice na h-Eireann  
 (R) Cowes. 27 May. Annual General Meeting, followed by annual outing  
 (FF) Dundee. 21 April. 7.15. Modern Aspects of Inorganic Chemistry. Prof. R. S. Nyholm. Queen's College  
 — 5 May. 7.15. Annual General Meeting. Queen's College  
 (F) Galway. 24 April. The Chemist and the Internal Combustion Engine. W. S. Sellers. University College. Joint, C.S., S.C.I. and Institiud Ceimice na h-Eireann  
 (K) Glasgow. 12 May. 4. Fourth Henderson Memorial Lecture: Tobacco Smoke and Lung Cancer. Dr J. W. Cook  
 (P) London. 24 April. 7. Fifth Ladies' Evening: Gem Stones. R. C. Chirnside. The Royal Institution, 21 Albemarle Street, W.1.  
 (Q) Manchester. 3 May. 7. Ladies' Evening: Protection for the Housewife. Mrs P. Garbutt. College of Science and Technology  
 (S) Newcastle. 5 May. 6.30. Annual General Meeting, followed by lecture on Sherry. D. M. G. Lloyd. Chem. Dept., King's College  
 (U) Sheffield. 4 May. 7.30. Annual General Meeting. Chemistry Lecture Theatre, The University, Brookhill  
 (R) Southampton. 20-22 April. Institute Annual Conference  
 (V) Swansea. 5 May. 3. Visit to new University Chemistry Laboratories. 6.15. Annual General Meeting, Department of Chemistry, The University College  
 (T) Wrexham. 26 April. 7. Some Aspects of Colour Reproduction. Dr H. Baines